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**A Prototype for Tracing Missing Children: A Case of Nairobi
County**



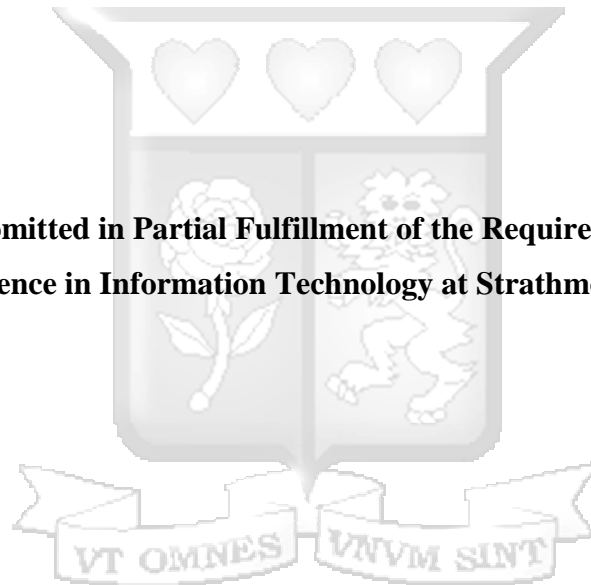
Master of Science in Information Technology

2016

A Prototype for Tracing Missing Children: A Case of Nairobi County

Ndeto Martin Ndithi

**A Research Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of
Master of Science in Information Technology at Strathmore University**



**Faculty of Information Technology
Strathmore University,
Nairobi, Kenya**

June, 2016

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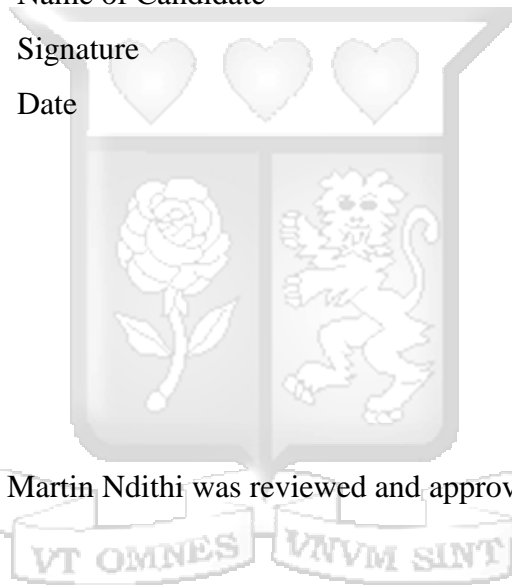
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Signature

.....

Date



Approval

The research thesis of Ndeto Martin Ndithi was reviewed and approved by:

Dr. Vitalis Ozianyi,

Lecturer, Faculty of Information Technology,

Strathmore University

Dr. Joseph Orero,

Dean, Faculty of Information Technology,

Strathmore University

Prof. Ruth Kiraka,

Dean, School of Graduate Studies,

Strathmore University

Abstract

Tracing missing children has been quite hectic for parents and care givers. A missing child is vulnerable to risks associated with drugs; poor health; involvement in criminal activities for survival, assaults, murder, rape and infection with killer diseases. Currently, there is lack of coordination in departments dealing with issues concerning children and no timeliness for the police department in handling this process. In addition, there is no convergence among the agencies involved in child protection. Several solutions have been proposed among them, the “App for the loved ones”; which has a central database and uses short messaging services (SMS) to send search terms that must have an exact match. Social media has been another approach capable of mobilizing volunteers to spread the information concerning the missing child at a fast rate. However, it lacks credibility since any one can author the information. A “CodeSearch” application was introduced in Canada which uses global positioning system (GPS) to send geo-targeted alerts to its subscribers. However, most people tend to have their GPS turned off unless when in use. It is also limited to employees of the CodeSearch partners. This research aims at introducing an expert system that uses ID3 algorithm to populate its knowledge base and an interactive search using the same algorithm. This allows users to interactively search the database, enter details about their missing loved ones if not yet found and notify them whenever the person is found. The search is based on the person’s phenotypes as they cut across the human race. The research is a form of applied research. The sample size was computed through convenience non-probability sampling. Most of the respondents recommended a proper system hence the reason for creating this prototype. The prototype is developed using V-Process methodology since the clarity of the user requirements was high and the technical expertise needed was readily available. The prototype produced 99% accuracy in tracing the missing children in the sample used.

Dedication

I dedicate this research to everyone who believed that I could make it and encouraged me in one way or another: my loving parents, siblings and friends.



Acknowledgements

I would like to express my gratitude to the Almighty God and my supervisor Dr. Ozianyi for his unfailing guidance and feedback which has greatly contributed to the successful completion of this thesis. In addition, I would like to appreciate Prof. Ateya for his guidance on undertaking this research. Finally, sincere gratitude goes to Mr. Nickson Kiunga, Director of Criminal Investigation (DCI) officer, for his wonderful support.



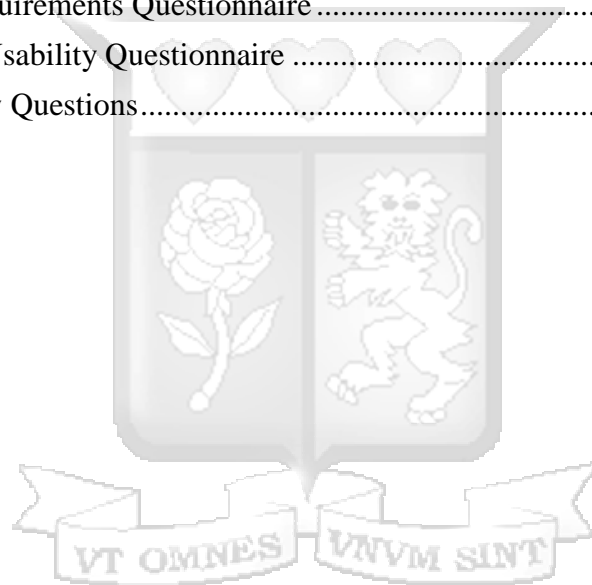
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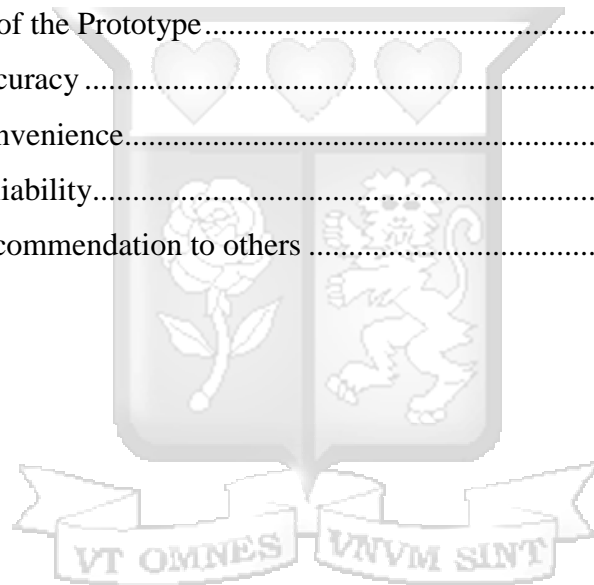
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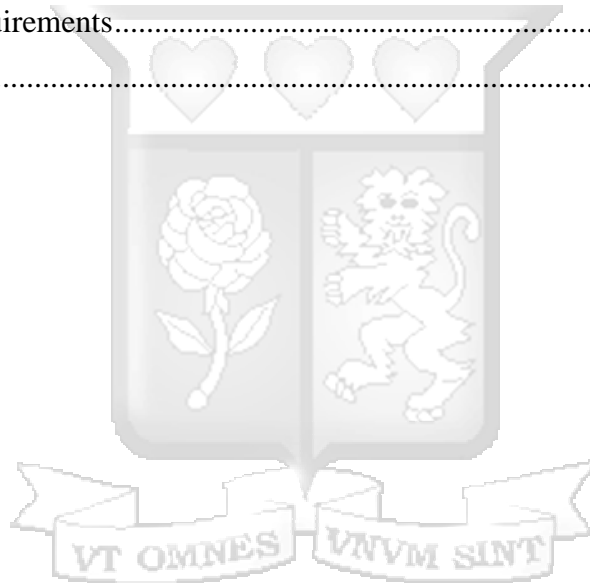
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Abbreviations/Acronyms

AI	-	Artificial Intelligence
CBD	-	Central Business District
CID	-	Criminal Investigation Department
DNA	-	Deoxyribonucleic Acid
GPS	-	Geographical Positioning Service
KB	-	Knowledge Base
KBS	-	Knowledge-Based System
KDD	-	Knowledge discovery in databases
NGO	-	Non-Governmental Organization
NIBs	-	National Information Bureaus
OB	-	Observation Book
PFIF	-	People Finder Interchange Format
UN	-	United Nations
UNHCR	-	United Nations High Commissioner for Refugees

Definition of Terms

Authorized Party: (In this context) an officer who handles issues which concern missing persons. (Examples: the police, Red Cross officers and children's offices personnel among others).

Found Person: A previously lost person who is now located and their well-being established (Association of Chief Police Officers, 2005).

Lost and Found (Item): An item which someone has lost and someone else has found it (Macmillan Publishers Limited, 2016).

Phenotypes: The observable characteristics of an organism (Weatherall, 2001).

Searcher: (In this context) someone searching for a missing friend/relative



Chapter 1: Introduction

1.1. Background of Study

A missing child is a child who has disappeared from home and his/her whereabouts cannot be traced (Jaswani, Chauhan, & Tyagi, 2015). Missing children can also be defined as children who have spent time away from where they ought to live, without the consent of the parents, or because they have been forced to leave by the parents (Shalev, 2010). Disappearance can be categorized into three categories. These include: lost person—a person who is temporarily disoriented and is open to be found; voluntarily missing—a person who has decided to leave home; missing under the influence of a third party—for example, a case of abduction; and missing as a result of an accident, illness or injury—for example, a mentally challenged person or struck by ‘hit and run’ vehicle and lying in an hospital with the relatives being unaware of his whereabouts (Grampian Police, 2007). Some of the reasons which result into disappearance include: leaving to earn a living; escaping domestic abuse; eloping; escaping perceived threat such as domestic violence; being sold to labor contractors or sex traffickers; and kidnapping among others (Jaswani, Chauhan, & Tyagi, 2015).

Any missing child is exposed to substantial risks. These risks range from drugs; poor health; involvement in criminal activities along streets in order to survive; assaults; murder; rape and infection with killer diseases (Shalev, 2010). These risks may lead to early deaths and case reduction of the working population in the near future.

Several children have disappeared from their residential homes and stayed in children’s home or other different children’s homes, if they disappeared from one, for more than six months without the knowledge of their parents and care givers (Child Welfare Society of Kenya, 2014 b). In Uganda as at September 2010, there were at least a hundred and twenty seven thousand refugees originating from the Democratic Republic of Congo; and over half a million Ugandan nationalities displaced in the event of the civil war in northern part, residing in camps (Irin, 2010 b). In addition, it took 12 days for a Sudanese refugee to reconnect with his family members (Irin, 2010 b). A Sudanese musician, formerly child soldier, made vast journeys in search of his family in vain. Finally his sister knew about him and was able to trace his whereabouts after he was interviewed by the British Broadcasting Corporation (BBC) (Irin, 2010 b).

In Kenya, the police are entrusted with the responsibility of tracing any missing person. This gives them the right of information from the Communications Authority of Kenya (CA) and other authorized information handlers such as the mobile telephone operators for the purpose of identifying any possible links with the disappearance of the person (Kiunga, 2016). In many countries, the police do not consider the process of tracing missing children a top priority issue and some even demand bribe in order to facilitate the process (The Hindu, 2013).

There is a mismatch among the figures of missing children collected from different related bodies which indicates the lack of convergence among the child protection agencies (The Hindu, 2013). As a result, most people tend to make the use of the social media platform to disseminate the information of missing, and lost and found persons (Li & Goodchild, 2010). The social is growing exponentially in Kenya. As at 30th November 2015, there were 31,985,048 internet users in Kenya (Miniwatts Marketing Group, 2016). 89% of these users go online to visit social networks (Google Consumer Barometer, 2015). This translates to around 28,466,693 people. However, the social media raises the concern of information credibility since everyone can author anything hence the information may lose its authenticity.

1.2. Problem Statement

There is lack of coordination in departments dealing with issues concerning children and timeliness for the police department in handling this process (The Hindu, 2013). The fact that a child can be housed in a children's home for quite a while without the care givers' knowledge even from searching from different police stations shows lack of convergence among the agencies involved in child protection (Child Welfare Society of Kenya, 2014 a). Based on these two issues, we can conclude that there is no effective system in place to report missing children and informing the parents and/or relatives whenever the child is found.

There is a need for proactive support from various sectors to address the issue of missing children in a systematic way (The Hindu, 2013). Effective mechanisms should be established to ensure coordination and information sharing (International Committee of the Red Cross, 2013). Tracing the missing children becomes nearly impossible when there is no database to capture and disseminate comprehensive information for the children (Birika, 2014). Therefore, there is a need for a scalable ICT solution that can help the child welfare agencies to efficiently trace missing children and promptly communicating to their care givers.

1.3. Research Objectives

- i. To identify useful data for tracing missing children.
- ii. To analyze the challenges tracing missing children.
- iii. To review the architectures and models used to trace missing children.
- iv. To develop a prototype for tracing missing children.
- v. To test the prototype

1.4. Research Questions

- i. What data are useful in tracing missing children?
- ii. What are the challenges in tracing missing children?
- iii. How are the current architectures and models used in tracing missing children?
- iv. How will the prototype be developed?
- v. How will the prototype be tested?

1.5. Justification

Everyone requires the basic needs, and in addition, affection from the family members. When children are exposed to numerous risks at their tender age, their learning trajectories tend to flatten (Potter & Redford, 2015). Missing children especially in towns are exposed to several vulnerabilities due to the high risk behavior along the streets especially at night. Since there are no designated sleeping areas for boys or girls, there is a risk of sexual exploitation hence the risk of sexually transmitted infections (Mandalazi, Banda, & Umar, 2013). If the child spends more time in the street, they are exposed to the risks of drugs; poor health; involvement in criminal activities along streets in order to survive; assaults and murder (Shalev, 2010).

This research therefore contributed in creating a mechanism for tracing the missing children. Through this, it minimized the risks exposed to the lost children as reduced the time used to conduct the search.

1.6. Scope and Limitations

The research focused on creating a prototype for tracing missing children using their phenotypes. The list of the lost and found sorely depended on the lost and found information entered by the police, children's homes and other designated authorities. For the lost people who are not in the lost and found list, the prototype provided a mechanism of capturing their

information from their loved ones and immediately sending notifications to their kin as soon as they are found, that is, lost and found.

The researcher wished to develop a fully functional system. However, due to limitations of time and other resources, the final product was a prototype covering only the basic functionalities.



Chapter 2: Literature Review

Every time a person, be it a child; a normal adult or a mentally challenged person is missing through running away, abduction or mysterious disappearance, there is a need to locate him/her as soon as possible. Adequate manpower and efficient cooperation among the bodies conducting the search is fundamental. This chapter discusses the concept of missing children; unique identifiable features of human beings which can aid in the identification; challenges faced in the process, approaches and architectures previously applied, and introduce the applicable concepts which could be used to offer a better solution to this menace.

2.1. Missing Children

Children easily get distracted and easily wander off. This means that it is very easy for a child to go missing especially when in a busy and crowded area. Around the world, approximately eight million children go missing every year (Center for Missing Children Kenya, 2015). In Kenya, the situation is not different. Hundreds of families are undergoing the agony of searching for their missing children. At least 35 cases of missing children are reported to police stations within Nairobi every month (Birika, 2014). This translates to about one or two children per day.

2.2. Human Phenotypes

To clearly differentiate individuals, several phenotypes can be considered. Among them include earlobe attachment, presence/absence of dimples, freckles, cleft chin, handedness, hair color and texture, hand clasping design, ability to roll the tongue and the shape of the hairline (McDonald, 2011).

Earlobe can either be directly attached or detached. Attached earlobe is usually connected to the lateral side of one's head (Ordu, Didia, & Egbunefu, 2014). Detached earlobe on the other side does not blend in and hangs freely away from the lateral side of head (Ahmed & Yaas, 2013). Figure 2.1 shows attached and free earlobes respectively.



Figure 2.1: Attached and Free Earlobes Respectively (University of Utah, 2015)

Dimples are small natural indentations which appear on either one or both sides of cheeks. They usually change with age. Some individuals are born with dimples while others develop them later in childhood; and live with them for the rest of their lives. Sometimes dimples disappear when the individual becomes an adult. Dimples appear mostly in children (Kumar, Kanojia, & Saili, 2014). Figure 2.2 shows cheeks with and without dimples respectively.



Figure 2.2: With and Without Dimples Respectively (University of Utah, 2015)

Freckles are usually small and concentrated spots in one's skin. They are a common occurrence in fair-skinned, red-haired people. It is not all light-skinned individuals have them. (University of Utah, 2015). Handedness can also be a distinct human characteristic. Some people have their right hand as more dominant than the left (University of Utah, 2015). Some individuals have a distinct depression on the bottom margin of their chin. They vary from small dimples to furrows. These types of chins are referred to as chin cleft or bi-lobed chins (Bhanu & Malhotra, 1972). Figure 2.3 shows a chin with a cleft and another without.



Figure 2.3: Chins with Cleft Present and Absent Respectively (University of Utah, 2015)

Hair color is as a result of melanin. These melanin pigments include red, blonde, black and brown (Keratin, n.d). Hair texture describes the thickness of every individual hair strand. It can be fine, medium and thick (coarse). In comparison to a piece of a thread, fine hair strand is thinner than the thread, medium hair has the same width as the thread while the thick strand is usually thicker than the thread (TextureMedia Inc, 2012). Hairline refers to how one's hair appears on the forehead. It can be straight or having a widow's peak as shown in Figure 2.4 (University of Utah, 2015).



Figure 2.4: Straight and Widow's Peak Hairlines Respectively (University of Utah, 2015)

Skin complexion acts as one of the most observable human features as it is notable from a distance. Among the complexions include albino, fair skinned, brown, olive, chocolate and black (Barsh, 2003). Some people have hairy fingers. This hair is referred to as mid-digital hair (McDonald, 2011). Figure 2.5 show some fingers with and others without the mid-digital hair respectively.



Figure 2.5: With and Without Mid-Digital Hair Respectively (McDonald, 2011)

Thumb also provides unique features among human beings. It is notable that, when straightened, some peoples' thumbs appear to be straight. Others curve at the last part and are referred to as hitchhikers thumb (University of Utah, 2015). This is shown in Figure 2.6



Figure 2.6: Straight and Hitchhikers Thumb Respectively (University of Utah, 2015)

With regard to handedness, some people are right-handed while others are left-handed. Some individuals are able to curl up the sides of their tongue and form a tube shape (McDonald, 2011). The ability to roll one's tongue is not a common feature among peoples. Some individuals can roll their tongues while others cannot, depending on their genes (McDonald, 2011). Figure 2.7 shows a rolled tongue and another which cannot be rolled.



Figure 2.7: Rolled Tongue and Non-rolled Tongue Respectively (McDonald, 2011)

2.3. Child Tracing Process in Kenya

Through the interview conducted, the researcher was able to understand the process of tracing a missing child, and reuniting a lost child to his/her family.

2.3.1. Tracing the Missing Child

Once a child goes missing, the care givers are required to report the matter to the nearest police station after twenty four hours. This is because the child is declared lost twenty hours after he/she goes missing (Kiunga, 2016). The police then register the case in the observation book (OB). After this, they notify the public and the media so as to aid in the search. Oral and print announcements are then made by the media officers. This helps in dissemination this information. From this point, the police rely on the public for any information which may lead to the tracing of the missing child.

2.3.2. Re-uniting the Lost and Found Child with the Family

When the public finds a child who is temporarily disoriented and is open to be found (lost), one is required to take the child to the nearest police station. The child is registered in the OB and given OB number. The child is then taken to children's offices for registration. The children's offices have the mandate of ensuring that the lost children are well accommodated and taken care of. The officer in charge goes to the court and registers the minor as lost. The child is then taken to a children's home (Kiunga, 2016).

After the parents identify the child in the children's home as theirs, they should explain the matter to the children's home officers. The parents then apply for an affidavit at the court that

the child is theirs. The court schedules a date when the parents should defend their claim. At first, they explain the circumstances in which the child got lost. If the court deems it as out of negligence, an action is taken against them. Otherwise, a deoxyribonucleic acid (DNA) test is carried out. If a match is established, a court order is issued to the children’s home to give out the child to the parents (Kiunga, 2016). A summary of these steps is shown in Figure 2.8.

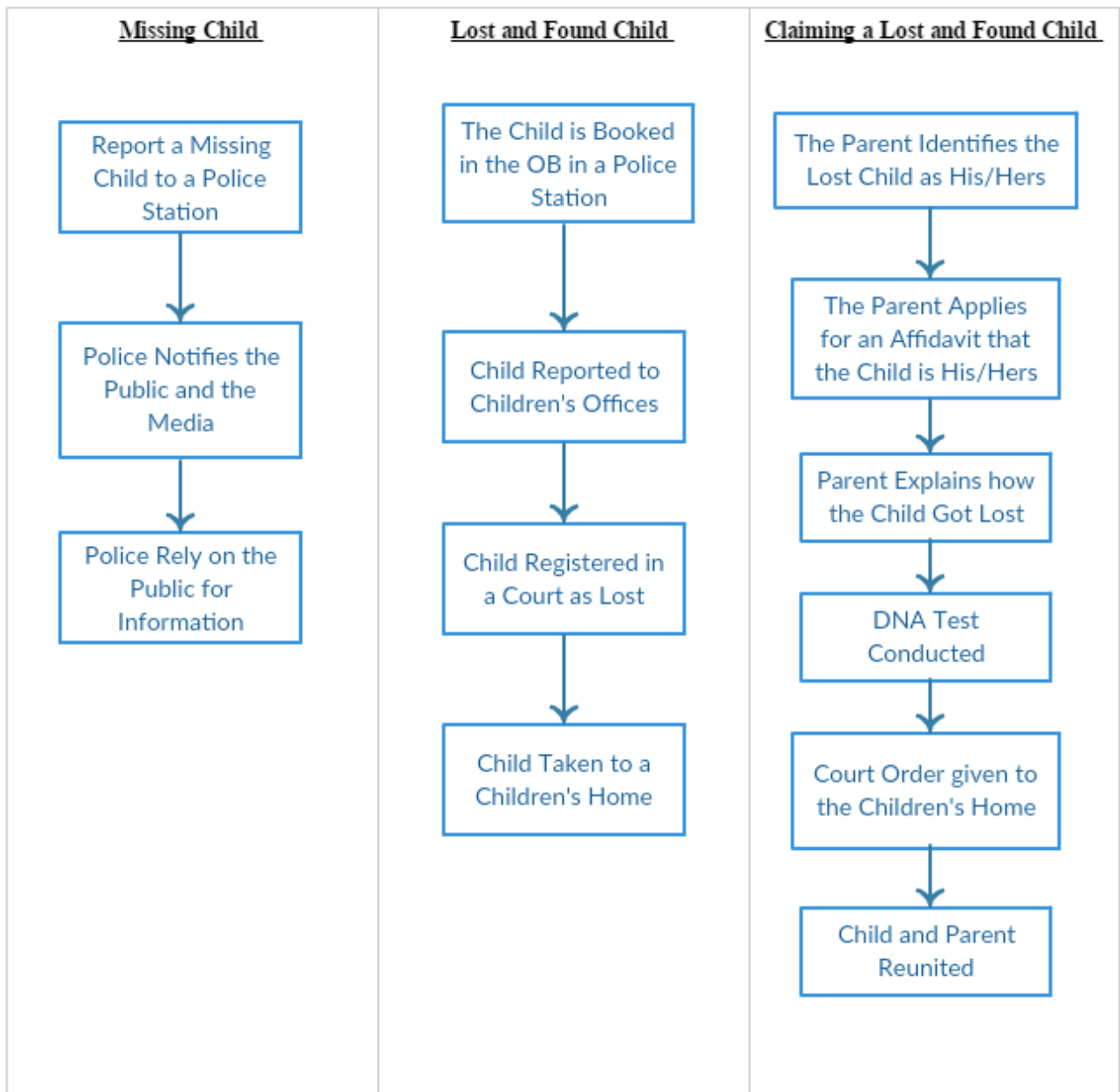


Figure 2.8: Child tracing process in Kenya (Kiunga, 2016)

2.4. Challenges in Tracing Missing Children

It is quite challenging to help someone to locate his/her home when he/she is unable to produce some leading information. This mostly happens to children, mentally challenged people and individuals who have lost memory as a result of an accident or another tragedy.

A case of India, a nine-year old child got lost in 2008, from Jahangirpuri slums. The police, the courts and the child rights commissions were unable to trace the minor. In addition, the police demanded a bribe so as to offer assistance despite the fact that the child was from a poor background (The Hindu, 2013). In this case, there was data mismatch among the tracking agencies. It was disturbing that the figures about the missing minors collected from the country's Zonal Integrated Police Network (ZIPNET) and National Crime Records Bureau (NCRB) greatly differed (The Hindu, 2013). This clearly shows that there is lack of coordination and convergence among the involved ministries and departments of the state. In addition, there is no timeliness for the police department for tracing the missing children hence lack of seriousness and apathy in handling this issue (The Hindu, 2013).

In Kenya, the Child Welfare Society of Kenya is responsible for handling most of issues affecting children, among them, tracing the missing ones. A baby boy got lost along Haile Selassie Avenue in Nairobi's Central Business District (CBD) as a stranger offered to hold the baby as the mother was alighting from a bus. The bus drove off soon after she alighted before picking her son. She headed straight to the bus terminus in order to pick the boy as the stranger alighted. However, she could not have a glimpse of neither the stranger nor the son. She searched at the possible bus terminus but all in vain. The mother reported the issue in three different police stations. A day after, her grievances were highlighted by the print media. She received a call from a woman claiming to have seen the boy in Kisumu but demanded to be sent bus fare in order to bring him to Nairobi. After six days of missing, a police officer from Kasarani Police Station called the media house and directed them to inform the mother that the child was in Child Welfare Society of Kenya along Langata Road (Child Welfare Society of Kenya, 2014 a).

Another family in a certain county was unable to trace their daughter for twelve years. The girl disappeared in 2002. The minor had been housed in one of children's home in Nairobi for all that duration (Child Welfare Society of Kenya, 2014 b). The family had already given up on the search. She was found when some of her relatives were engaged in charitable acts of

visiting and donating food stuffs in children's' homes. A similar occurrence happened to seven year old daughter. The girl went missing for six months from their home in Shauri Moyo in Nairobi. She was later traced to Mama Ngina Children's Home in South C estate in Nairobi (Child Welfare Society of Kenya, 2014 b).

As discussed earlier, the missing children are exposed to substantial risk. The challenges discussed in these cases among others can be attributed to the lack of effective means of disseminating the information among the involved parties.

2.5. Approaches for Tracing Missing Children

When a child goes missing, the relatives are usually required to report the matter to the relevant child protection agencies. This should be done in a professional manner. If there are several bodies handling the process of tracing the missing children, there should be a convergence amongst them (The Hindu, 2013). Several approaches have been designed with a sole aim of ensuring that whereabouts of any missing person can be easily identified. Among them include the Red Cross Society approach, an application for loved ones, the Google Person Finder, CodeSearch™ application and the social media approach among others.

2.5.1. The Red Cross Society Approach

This approach is used by the Red Cross Society. It has two main phases namely, the request to trace the person and tracing the person.

a) The Request to Trace the Missing Person

In the first phase, a person with a legitimate interest (searcher) reports the missing person. The searcher may be a family member, dependent, friends, neighbors, anyone with reliable information about the missing person or a legal representative of the missing person or his/her family (International Committee of the Red Cross, 2013). The reporting is usually done at designated local authorities who include the police and Red Cross officers at tents located at designated areas (International Committee of the Red Cross, 2013). Before the commencement of the search, the involved parties have the responsibility of clarifying and/or giving all the necessary information (Irin, 2010 a).

b) Tracing the Missing Person

As soon as the reporting is done, the pertinent public agencies have the obligation of conducting effective investigations. There may be several agencies and therefore coordination and cooperation amongst them is essential. Most of the information concerning the tracing and identification of the missing person emanates from the government agencies and ministries at both local and national levels. These pertinent ministries and institutions ought therefore to be unambiguously committed to the process of collecting and processing the related information; and actively support all the activities involved in the whole process (International Committee of the Red Cross, 2013). It is recommended that states, at the national level, ensure that there is an independent authority or a body responsible for the act of tracing the lost ones and to identify the human remains if the missing person died (International Committee of the Red Cross, 2013).

In case a state is undergoing armed conflicts, National Information Bureaus (NIBs) should be set up. This is to centralize information on the people unaccounted for, without any form of discrimination among them and take care of their family needs. As soon as the conflict ends, the NIBs should then commence the tracing process as they would have collected a great deal of relevant information. The other related government bodies such as the commissions on missing persons, human right commissions, presidential commissions of enquiry, truth commissions and ombudsmen among others should be put into action in order to address the violations of human rights (International Committee of the Red Cross, 2013).

2.5.2. An Application for Lost Loved Ones

In a joint venture between United Nations (UN), a Non-Governmental Organization (NGO) and two private companies, an online database of missing people which is accessible through mobile phones was built. The database grows by hundreds weekly as they reach out to the refugees in camps and urban areas (Irin, 2010 b). Users do not require internet to perform the search, thanks to the teaming up of United Nations High Commissioner for Refugees (UNHCR), service provider MTN; a South African based multinational mobile telecommunications firm which operates in many Asian, European and African countries, mobile phone manufacturer Ericsson and Refugees United. Ericsson and Refugees United distribute mobile phones to the UNHCR and other related refugee bodies (Irin, 2010 b). The piloting of the project started in Uganda and set to expand to Kenya, Sudan and finally, globally. As at September 2010, people of at least eighty nationalities were already captured in the database.

There are two distinct modules in this system: keying in the details of the lost and found person into the system and searching for the missing person using their name, home town/village, birthplace and number of siblings among other key terms (Irin, 2010 b). Based on this information, the architecture of this application can be summarized as shown in Figure 2.9.

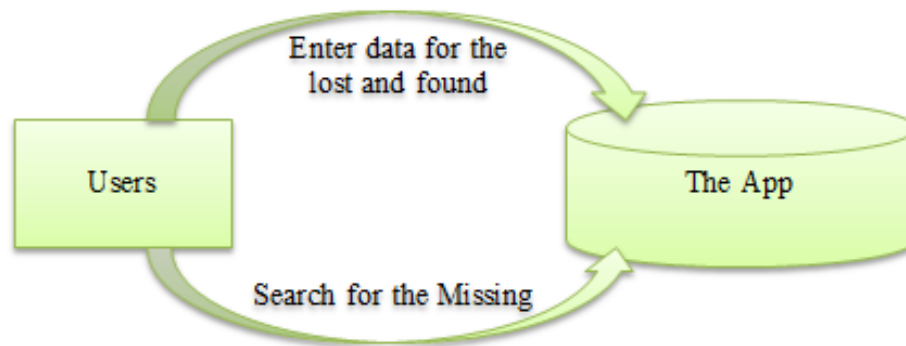


Figure 2.9: An Application for the Loved Ones Architecture

2.5.3. Google Person Finder

Google Person Finder is a web application that allows individuals to post and search for the status of friends and relatives who are affected by any disaster (Google, n.d). This software allows non-governmental agencies, press agencies and other participants to add data to the database and receive updates on the statuses of the missing people through the use of the People Finder API which is based on the People Finder Interchange Format (PFIF) open standard. PFIF is a combination of a data model and an XML-based exchange format for sharing information on missing people or people displaced by either man-made or natural disasters (Google, n.d). This application can be embedded as a gadget on websites. It is open source and runs on the Google App Engine Platform with the support of over forty (40) languages among them, the commonly used languages in countries prone to disasters (Google, n.d).

2.5.4. The Social Media Approach

Social media are platforms providing a social community for a group of persons with common interests (Ahmad, 2011). Most of these media provide voice, videoconferencing, chats and instant messages among other collaborative services. They usually act as an online community for the internet users (Ahmad, 2011).

The social networks offer a fast platform for dissemination of information. They are able to mobilize the target volunteers in the dissemination process due to the relationships and the interactions among users (Li & Goodchild, 2010). They also offer insights for information gathering especially through data mining.

In as much as the information flows at a faster rate, there may be questions regarding its quality and credibility due to the lack of authoritative source as it is generated by volunteers (Li & Goodchild, 2010). Due to this, the social media users may opt to wait for an official communication on the same which may then delay the dispersion process. There may also be a conflict between the information circulating in the social media and the official one (Li & Goodchild, 2010).

2.5.5. The CodeSearch Application

CodeSearchTM is a mobile app which works just like a social media tool. Volunteers, strictly the CodeSearch partner employees, download the app into their smartphones and sign up as field agents. The app uses the geographical positioning service (GPS) to send geo-targeted alerts to the field agents in the event of a missing child in a given location (Mouallem, 2015).

2.6. Summary of the Approaches

The approaches previously discussed have numerous advantages. However, each possesses some notable demerits. These are summarized in Table 2.1.

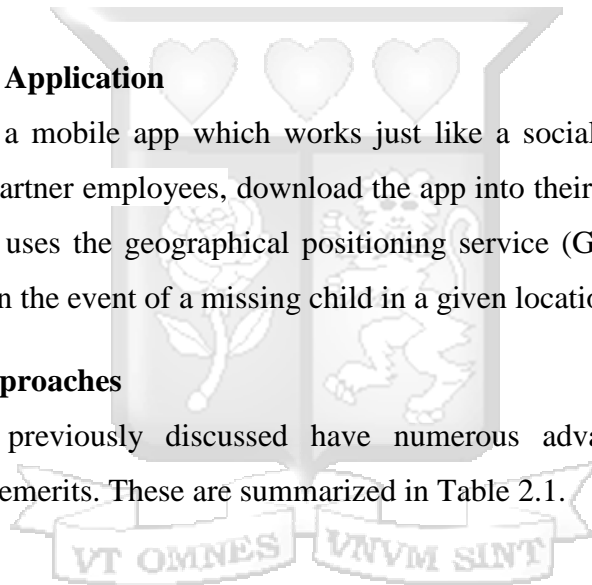


Table 2.1: Summary of the Approaches

Approach	Merits	Demerits
The Red Cross Society Approach	Identifies the basic steps in identifying the missing persons.	The search is extremely manual
An Application for Lost Loved Ones	Has a central database for the missing persons. Does not require internet connection as it uses short messaging services (SMS)	The search terms must exactly match the information stored in the database. International SMS services are more expensive than internet.
Google Person Finder	Easily accessible since it is a Web Application	Anyone can post hence the information loses its credibility.
The Social Media Approach	Fast dissemination of information	Posting photos online without the consent of the owner is an infringement of one's privacy. The information may lack credibility
The CodeSearch Application	Sends geo-targeted alerts	Not all people have their smartphones' GPS service turned on. It is limited to employees of CodeSearch partners.

2.7. The Child Tracing Concept

2.7.1. Traceability Models

Traceability refers to the extent to which a relationship exists between two or more products of the development process, especially products having a predecessor-successor or master-subordinate relationship to one another (Qasaimah & Abran, 2013). A typical traceability model takes care of the flow of an item from its start to its completion (Kirova, Kirby, Kothari, & Childress, 2008). Taking an example of software development process, the process can be traced through a number of stages. These stages include but not limited to the following artifacts:

- i. Request definition and assessment form (RDAF) to obtain high level user needs.
- ii. Features which are derived from the requests from RDAF.
- iii. Performance architecture requirements document (PARAD).
- iv. Feature definition document (FDD). This has both high-level non-functional and functional requirements.
- v. Systems requirement document (SRD). This contains both lower-level non-functional and functional requirements.

Such a traceability model is illustrated in Figure 2.10. This traceability model can also be revised and applied in tracing a missing child.

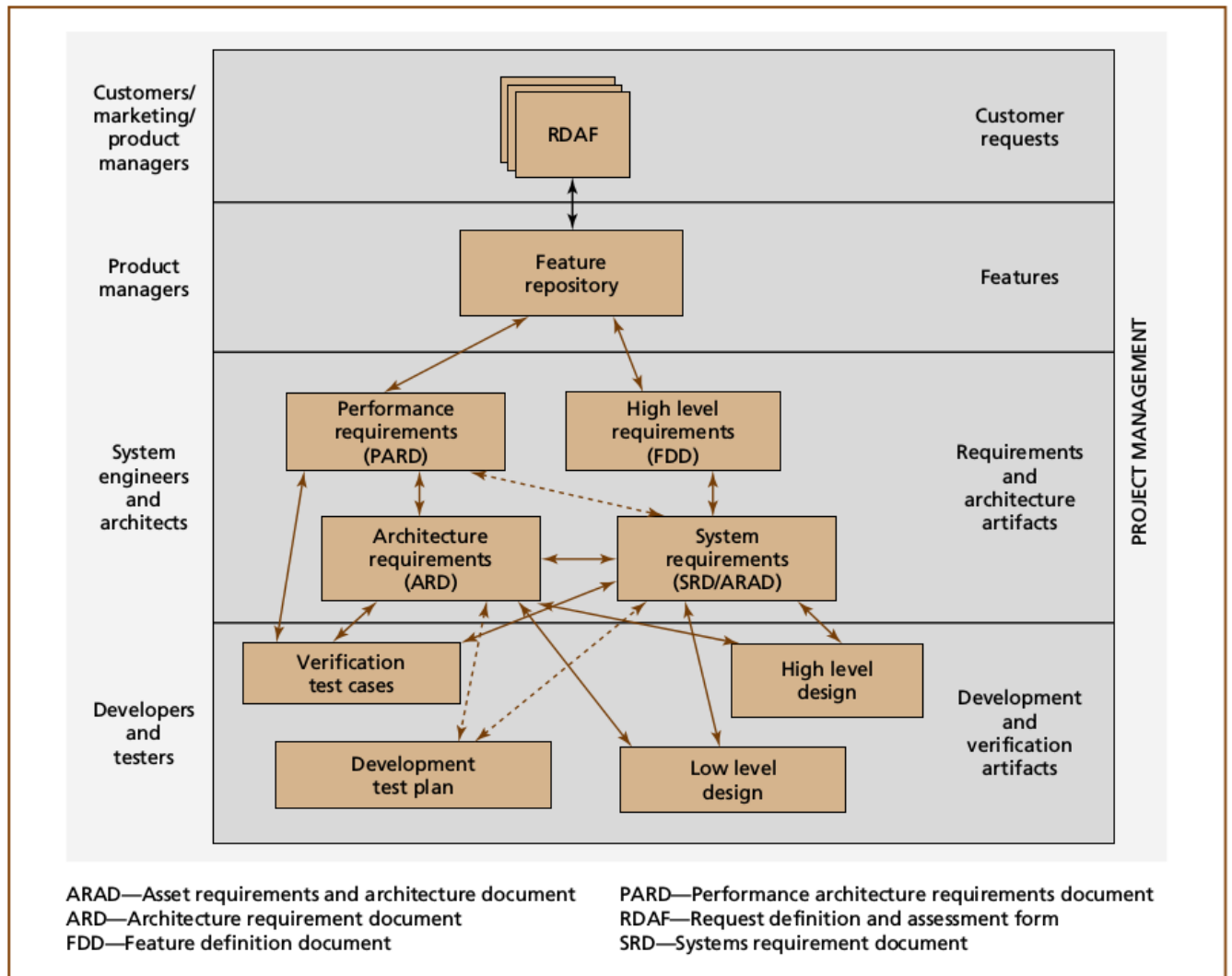


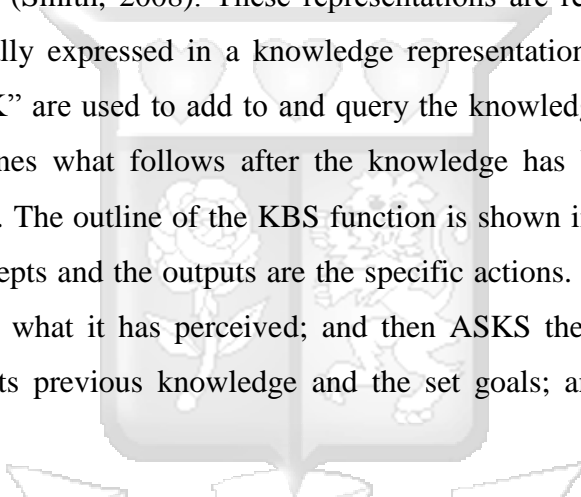
Figure 2.10: A Typical Traceability Model (Kirova, Kirby, Kothari, & Childress, 2008)

2.7.2. Artificial Intelligence

Artificial Intelligence (AI) is simply the study of agents that exist in an environment and have the ability to perceive and act (Russell & Norvig, 2013). AI attempts to understand intelligent entities of the human beings and construction of artificial entities with human-level or better intelligence with the ability to think humanly, act humanly, think rationally and act rationally (Donalek, 2011).

2.7.3. Knowledge Based Systems

All knowledge-based systems/agents (KBS) have their central component as their knowledge base (KB). A knowledge base can be literally be defined as a set of representations of the facts about the world (Smith, 2008). These representations are referred to as “sentences”. These sentences are usually expressed in a knowledge representation language. The standard names “TELL” and “ASK” are used to add to and query the knowledge base respectively. The inference engine determines what follows after the knowledge has been added into the KB (Russell & Norvig, 2013). The outline of the KBS function is shown in Figure 2.11. The inputs into the KBS are the percepts and the outputs are the specific actions. Whenever the function is called; it TELLS the KB what it has perceived; and then ASKS the KB on the best/optimal action to execute using its previous knowledge and the set goals; and performs the selected action (Smith, 2008).



```
function KB-AGENT(percept) returns an action  
static: KB, a knowledge base  
       t, a counter, initially 0, indicating time  
  
TELL(KB, MAKE-PERCEPT-SENTENCE(percept, t))  
action ← ASK(KB, MAKE-ACTION-QUERY(t))  
TELL(KB, MAKE-ACTION-SENTENCE(action, t))  
t ← t + 1  
return action
```

Figure 2.11: A Generic Knowledge-based Agent (Russell & Norvig, 2013)

2.7.4. Expert Systems

An expert system is an intelligent computer program that uses knowledge and inference procedures to solve problems that are difficult enough to require significant human expertise for their solutions. A domain is the field within which the specific task is being executed (Feigenbaum, 1980). An expert is someone with hands on experience in solving a problem in a certain domain (Purwadi, 2009). Expert systems have greatly reduced time in making decisions and increased the quality of the decisions. (Bensoussan, Mookerjee, Mookerjee, & Yue, 2009).

The major components of an expert system are the knowledge base, the inference engine and the user interface (Artificial Intelligence, 2010). The knowledge base contains the expert knowledge of the domain which is stored in a knowledge representation form; the inference engine performs the inference reasoning tasks using both the knowledge in the knowledge base and the information supplied by the user; while the user interface offers a communication exchange between the system and the user (Purwadi, 2009). From these three components, we can breakdown further to working memory, knowledge database, domain database, explanation facility, knowledge acquisition facility and a self-training facility. A working memory is simply a global database containing the facts that are used by the rules. The knowledge database contains all the rules concerning how the elements of a particular subject behave. The domain database contains all the facts concerning the expert system's subject. For the user to understand the reasoning of the system, the explanation facility comes into play. Since there should be a mechanism of creating and growing the knowledge base, a knowledge acquisition facility is required. This is usually an automatic way of knowledge entry from the expert into the system. Finally, the self-training facility ensures an automatic process for the system to add new rules and/or facts into its knowledge base (Purwadi, 2009). This architecture is shown in Figure 2.12.

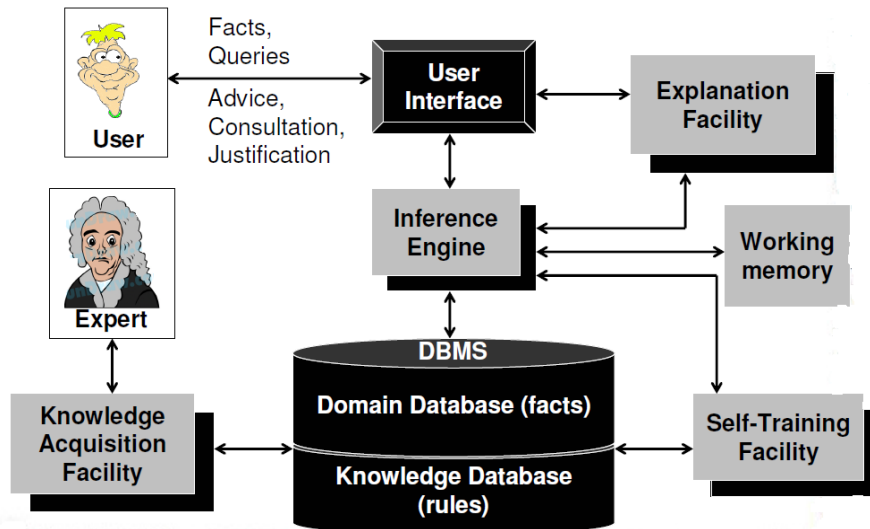


Figure 2.12: Expert System Architecture (Purwadi, 2009)

2.7.5. Unsupervised Learning

In order to grow the knowledge base, the agent or rather the system has to learn from past experiences. It can learn through supervised, unsupervised or reinforcement learning method. Unsupervised learning is where the agent has no hint at all about the correct output (Ghahramani, 2004). The unsupervised learner is able to learn the existing relationships among its percepts through the use of supervised learning methods. This means that it can learn to predict its future percepts using its previous percepts. This is made possible by a utility function (Russell & Norvig, 2013).

2.7.6. Decision Trees Inducers

By definition, a decision tree is usually a form of classifier which is expressed as a recursive partition of the instance space (Rokach & Maimon, 2010). It consists of nodes flowing from the root node to down to the leaf nodes. The intermediate nodes are split in accordance to a certain discrete function. Instances are classified from the root node according to the test outcomes down the leaf nodes (Rokach & Maimon, 2010).

Decision tree are automatically constructed from the given datasets using divide-and-conquer algorithms also called the decision tree inducers. These algorithms have a major goal of finding the optimal tree by minimizing the generalization error (Hickey, 2007). Among these

decision tree inducers is the ID3 algorithm. This algorithm uses information gain as the criteria for splitting (Watanabe & Rendell, 2007). The growing continues until the best information gain is zero or less; or all the instances are assigned to a single value of target feature (Rokach & Maimon, 2010). Rules are extracted through the association of the path from the root to the leaf node. These induced rules are then used to classify new examples (Hickey, 2007).

Decision trees are capable of handling erroneous and incomplete datasets. They are a nonparametric as they do not have assumptions on the classifier structure and the distribution space. Since the decision trees can easily be converted into rules, it can be a possibly an easier way of generating the knowledge base. Finally, decision trees provide a rich representation of discrete values (Rokach & Maimon, 2010).

a) Entropy

Entropy is a simply the measure of impurity (Jiang & Petkov, 2009). In an arbitrary categorization, let us say C in categories $c_1, c_2, c_3, \dots, c_n$, and a set of examples whose proportions in c_1 is p_1, c_2 is p_2, \dots, c_n is p_n ; the entropy is computed as shown in equation 2.1.

$$Entropy(S) = \sum_{i=1}^n -p_i \log_2 p_i$$

Eq (2.1)

b) Information Gain

Information gain is computing using entropy in (a). It is given by the difference between the entropy of the parent and that of a child. It helps in choosing the best attribute to be tested at each node of the decision tree. Information gain of a target outcome T given predictor attribute X is given by the difference between the entropy of the target outcome T and the entropy of target outcome T given predictor attribute X (Nowozin, 2012). This is summarized in equation 2.2.

$$Information\ Gain(T, X) = Entropy(T) - Entropy(T, X)$$

Eq (2.2)

2.8. Conceptual Framework

From this literature, the researcher has conceptualized the use of an expert system to help in tracing the missing children. From the “Application for the loved ones”, the researcher borrows the idea of having a database for both the missing and the lost and found children. In order to have authentic information on the lost and found children, we borrow the segregation of responsibilities from the Red Cross approach and have the police, children’s homes and other designated authorities enter the information. The ID3 algorithm used in decision trees can be applied to ensure that the attributes which matter are chosen from the database while generating dynamic rules of the knowledge base since the data for both the missing and the lost and found is dynamic. This form of learning (growing the knowledge base) is unsupervised learning. This will also help in creating interactive search. Just like how the social media approach sends alerts, similar alerts can be applied in this case to notify the persons with a legitimate interest (searchers) whenever a missing person is registered under lost and found. As discussed in section 1.1, 31,985,048 Kenyans have access to the internet, hence the choice of the web-based solution. The conceptual framework is summarized in Figure 2.13.

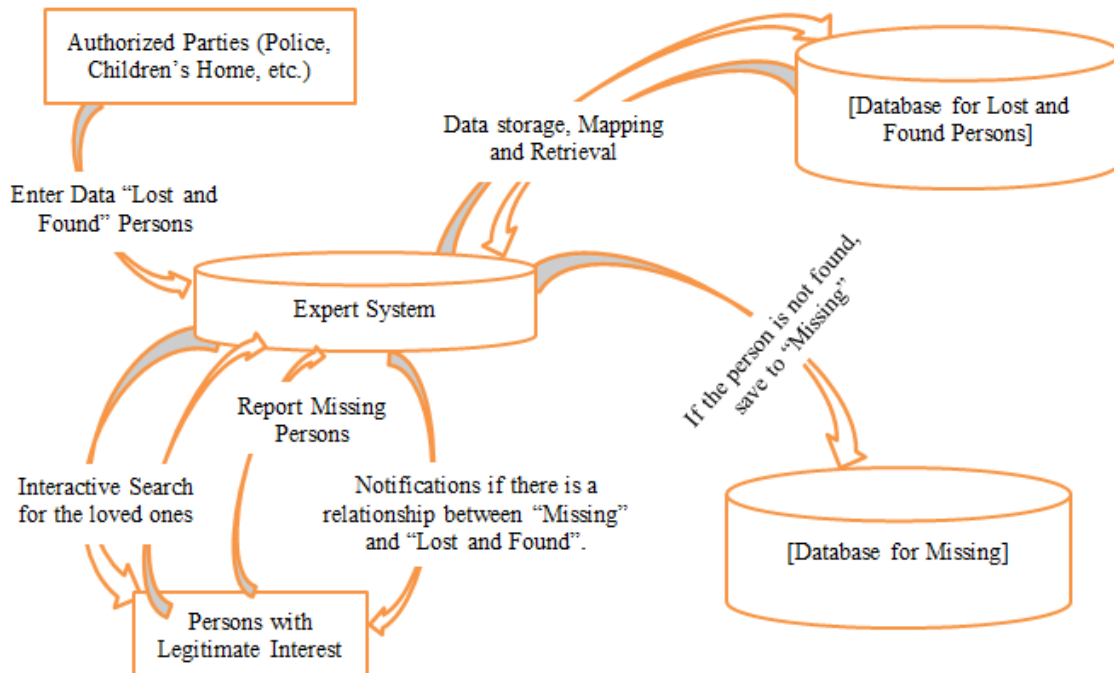


Figure 2.13: Conceptual Framework for the Proposed Prototype

Chapter 3: Research Methodology/Design

3.1. Introduction

This chapter discusses the research strategy, tools and techniques applied and how they were applied. It also describes the population and the sampling technique to be used in collecting the data.

3.2. Research Design

This was an applied research and used quantitative research methods so as to examine the relationship between variables and aimed to analyze and represent that relationship mathematically through statistical analysis.

Its purpose was geared towards providing information that is required and applied in order to ensure that the target audience understood and accurately traced the missing children. It was more prescriptive and sought to provide potential solutions to the problem at hand.

The prototype was developed using rapid application development (RAD) methodology. This methodology is appropriate due to its iterative nature and the limitation of time and other resources for the researcher. This approach offers fast development and delivery of optimal quality software at a cost which is relatively low. This inherently reduced the overall risk as it broke the prototype into smaller manageable subtasks (Nashawaty, 2015).

3.3. System Development Methodology

A system development methodology is the framework for structuring, planning, and controlling the information development process (Centres for Medicare & Medicaid Services, 2008). Since the clarity of the user requirements was high and the technical expertise needed was readily available, the researcher applied the V-Process model (Khan, Parveen, & Sadiq, 2014). V-Process model is simply a Verification and Validation model. It follows a sequential execution of processes. Each development phase has corresponding test cases (Khan & Beg, 2013).

The first phase involves user requirements gathering and analysis. This forms the basis for system design and user acceptance testing (UAT) when the system goes live. The system design phase extracts the desired design form the user requirements and also creates a system test

design. The architecture design and module phases follow with their test designs as shown in Figure 3.1. The module design is then converted into a working system by the programmer.

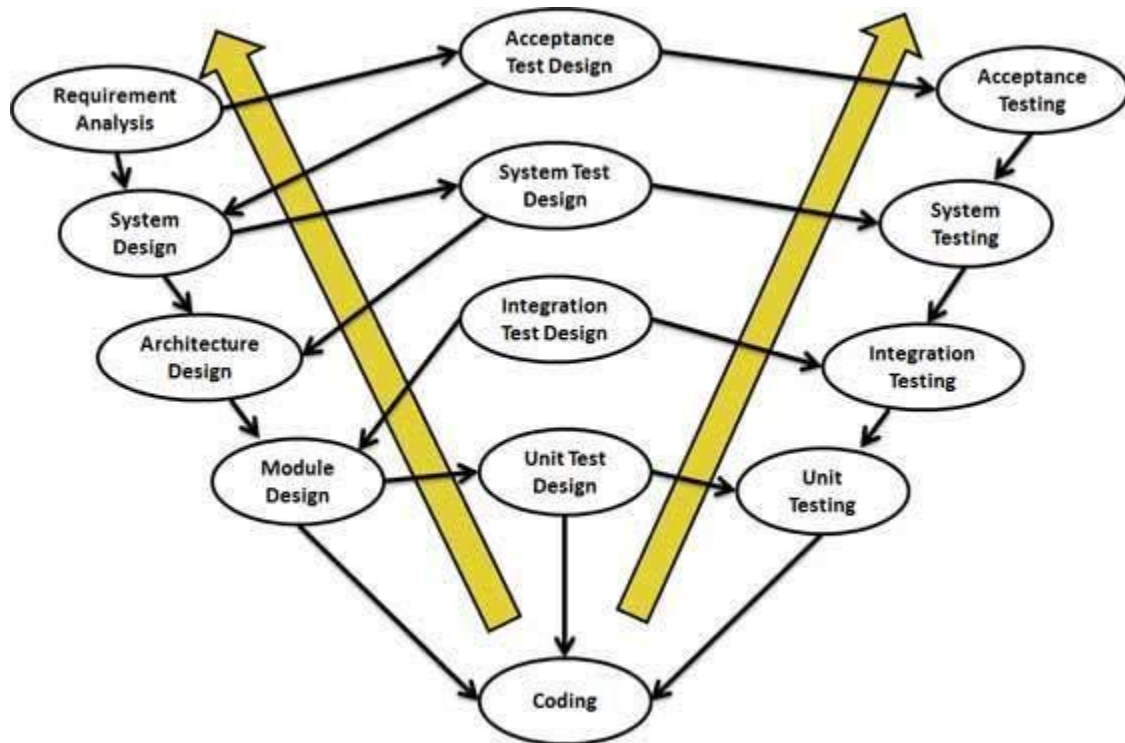


Figure 3.1: V-Process Model (Khan & Beg, 2013)

3.4. Population and Sampling

This research was based in Nairobi County, Kenya. The target population was composed of the parenting population aged between 25 and 54 years. As at December 2009, this population stood at approximately 1,336,694 people (Kenya National Bureau of Statistics, 2010).

The participants were selected through convenience non-probability sampling since the researcher is bound by time and other resources. The researcher applied random sampling technique in order to obtain the desired sample size. To obtain the required sample size, equation 3.1 was used.

$$n = \frac{N}{1 + N(e)^2}$$

Eq (3.1)

Where:

n = Sample size (100)

N = Total Population (1,336,694)

e = Margin of Error (10%)

3.5. Data Collection and Requirements Gathering

During this research, the researcher aimed at collecting both primary and secondary data.

This involved:

- i. Structured online questionnaires—these were administered before and after developing the prototype. Before developing the prototype, the researcher wanted to understand the user requirements. After the prototype was developed, the structured online questionnaires played a key role in gathering information on how the target users felt about the newly developed child tracing prototype. The researcher chose the online questionnaires for their convenience.
- ii. Interviews—this was used to gather information from the police. Interviews offered a better approach to understanding the current process of tracing a missing child and reuniting a lost and found child to his/her family. Open interviews provided an avenue for more explanations which helped the researcher to understand the process better. They also played a very crucial role in gathering user requirements.
- iii. Secondary data collection—to understand the existing worldwide standards for business automation, the researcher studied several architectures, frameworks, tools and technologies which are not resource intensive yet effective. This aided in selecting the optimal development tools and technologies.

3.6. Data and Requirements Analysis and Presentation

This is involved organizing data collected and breaking it further into smaller parts which could be easily understood. Quantitative data was analyzed using Microsoft Excel. Microsoft Excel allows for a number of statistical analysis functionalities. Data analysis results were presented using the following tools:

- i. Tables—to summarize the significant variables.
- ii. Pie Charts—to provide a visual representation of the quantitative data and to facilitate comparison and correlations within the data.

User requirements were analyzed and system design models generated. These included dataflow diagrams (DFDs), use case models, sequence diagrams, sequence diagrams, entity relationship diagrams (ERDs) and class diagrams.

3.7. Research Validity and Reliability

To ensure the research validity, the researcher ensured that the data collected from the respondents was relevant. The researcher’s academic supervisor thoroughly checked study so as to ensure that it matches the research objectives. The researcher ensured the research reliability by following the thesis guideline provided by the university and international research standards.

Test cases were also developed and used to test the functionalities of the major milestones. Due to limitation of time, only the unit (developer) testing was done. This followed the xUnit Framework as shown in Figure 3.2.

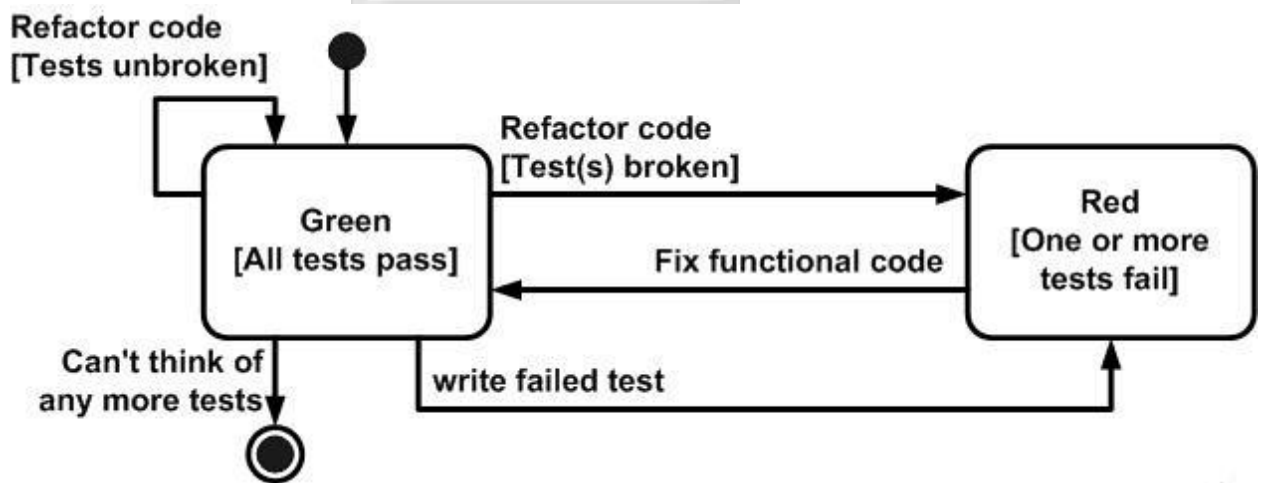


Figure 3.2: The xUnit Testing Framework (Bajaj, Patel, & Patel, 2015)

3.8. Ethical Considerations

To uphold ethical standards, the researcher had to obtain consent the selected participants before the survey. The data gathered was treated with a high degree of confidentiality and was solely used for the purpose of this research. All the questionnaires had a disclaimer.

Chapter 4: System Analysis and Design

System design is the process of defining the top-down description the system's structure (architecture), modules, interfaces, components for a system in order to satisfy the specified user requirements (Faisandier, 2012). This process involves collecting and analyzing user requirements and modeling them in both conceptual and logical representation.

4.1. Data Analysis and Findings

To extensively gather user requirements, questionnaires were administered to the general public (searchers). Interviews were also done to Criminal Investigation Department (CID) officer in the in order to understand how the child tracing process is currently done. The results were analyzed and presented using pie charts as shown.

4.1.1. Ease of tracing a missing child

As illustrated in Figure 4.1, 40% of the searchers said that it was extremely hard to trace a missing child even if the child was in safe hands (with the police or transferred to a children's home). 20% responded that it was hard, 16% were neutral, 14% said that it was not hard and 10% said that it was easy to trace the child provided that the child was in safe hands.

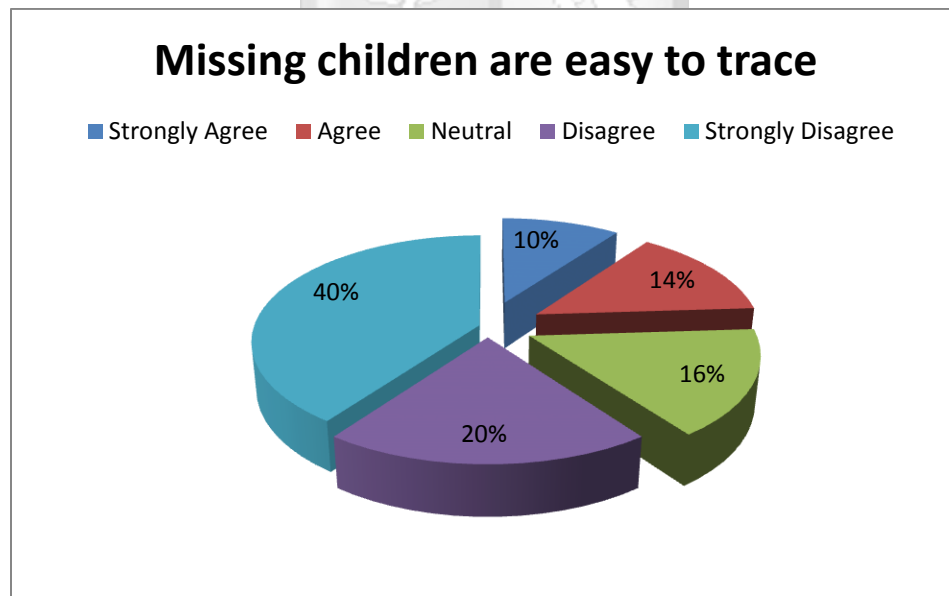


Figure 4.1: Ease of tracing a missing child

4.1.2. Efficiency of the Current Method of Tracing Missing Persons

60% of the respondents strongly disagreed that the current method of tracing a missing child was efficient. 24% disagreed, 6% were neutral about the matter, 8% agreed that the process was efficient and 2% strongly agreed to this claim. This shows that the current method is not efficient and is illustrated in Figure 4.2.

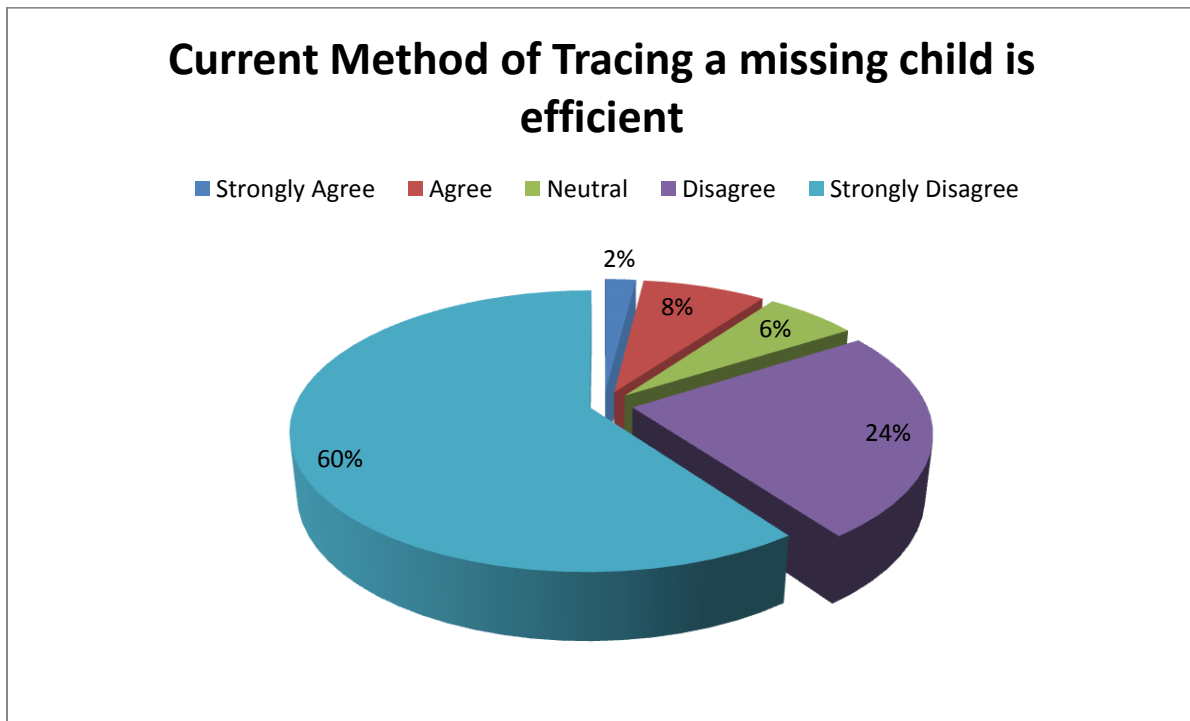


Figure 4.2: Efficiency of the current method of reporting missing persons

4.1.3. Notifications by the Current Systems to the Searchers

When the missing person is found by the authorities, 52% of the respondents strongly disagreed that the searchers are promptly notified. 30% disagreed, 10% were neutral or had no idea, 6% agreed and 2% strongly agreed that the searchers are notified in time. This is illustrated in Figure 4.3.

Searchers are promptly alerted when the missing person is found

■ Strongly Agree ■ Agree ■ Neutral ■ Disagree ■ Strongly Disagree

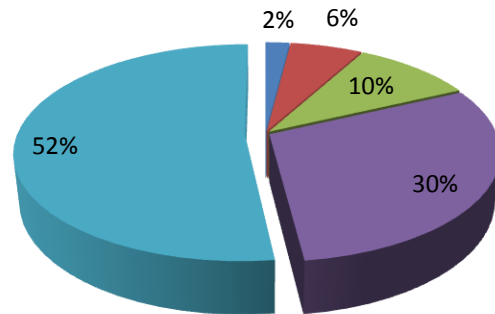


Figure 4.3: Notifications by the current systems to the searchers

4.1.4. User-friendliness of the Current System

As shown in Figure 4.4, 30% strongly disagreed with the claim that the current system/process was user friendly. 24% disagreed, 20% were neutral, 14% agreed and 12% strongly agreed that the systems in place are user friendly.

The current processes are user friendly

■ Strongly Agree ■ Agree ■ Neutral ■ Disagree ■ Strongly Disagree

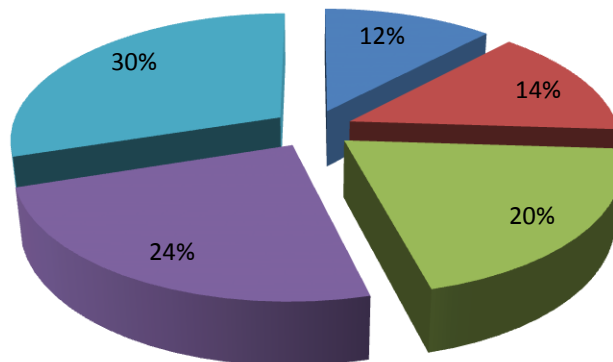


Figure 4.4: User-friendliness of the current system

4.1.5. Security of the Current System

Concerning the security of the current systems for tracing a missing child and the whether the records are safely stored, 14 % of the respondents strongly felt that the security issue in these systems was very poor. 24% felt the same but with less intensity, 34% had no clue (neutral), 18% approved the current security status as good and 10% strongly agreed that the security status is fine. This is shown in Figure 4.5.

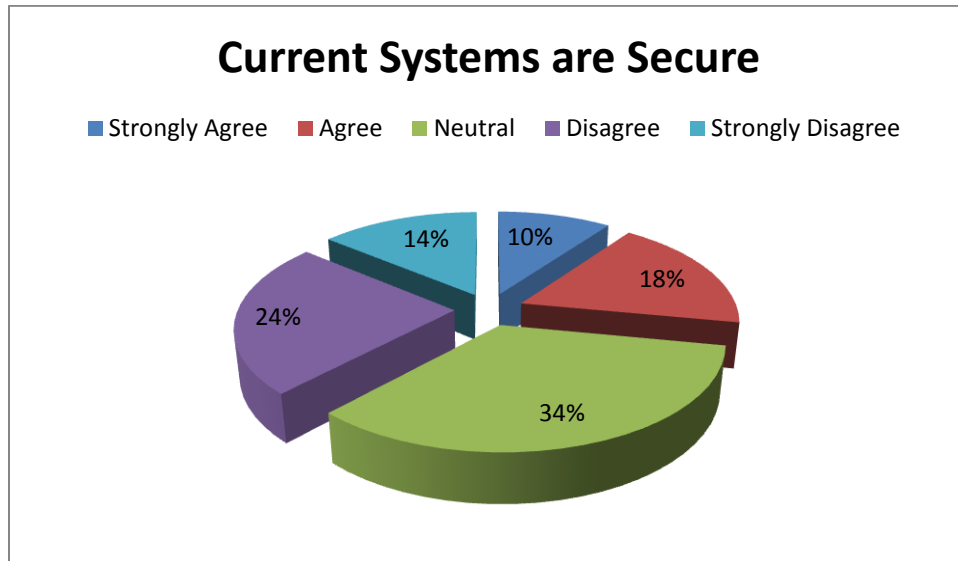


Figure 4.5: Security of the current system

4.1.6. Recommendations for a Proper System

52% of the respondent strongly agreed that this process would be much easier if a proper system was put in place. 30% agreed, 10% were neutral, 4% disagreed and 4% strongly disagreed to this claim. Figure 4.6 shows the distribution of these responses.

Process would be easier if proper systems are put in place

■ Strongly Agree ■ Agree ■ Neutral ■ Disagree ■ Strongly Disagree

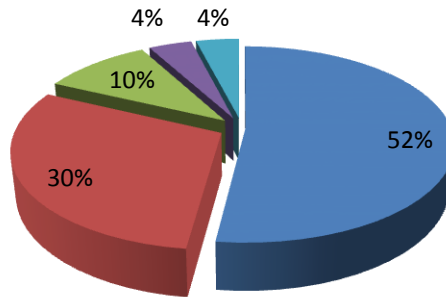


Figure 4.6: Recommendations for a proper system

4.1.7. Sensitivity in Giving out Personal Information of the Loved Ones

60% of the respondents said that they were very sensitive in giving out personal information of their loved ones. 26% were not very sensitive, 10% were neutral and 4% never cared. This is illustrated in Figure 4.7.

Sensitivity in giving out personal information for loved ones

■ Very Sensitive ■ Not Very Sensitive ■ Neutral ■ I do not care

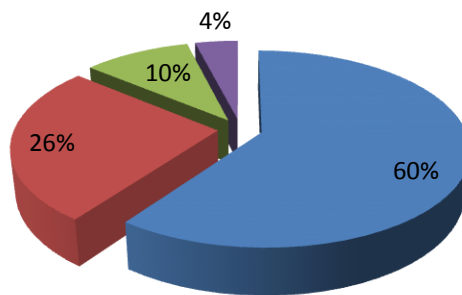


Figure 4.7: Sensitivity in giving out personal information of the loved ones

4.2. Requirements for the Proposed System

4.2.1. User Requirements

Through the questionnaire administered, the research found out that the users needed:

- i. A system that would enable anyone to search for their lost loved ones within the shortest time possible.
- ii. A system through which anyone can enter the details of their lost ones if not yet classified as lost and found.
- iii. A system that would notify the concerned relatives whenever the missing person is entered as lost and found.
- iv. A user friendly and intuitive system.
- v. A secure system in terms of privacy issues and access.
- vi. A system which generates intelligent reports crucial for decision making.

The user requirements were then grouped into functional and non-functional requirements. Functional requirements capture the intended functioning of a system while the non-functional requirements form constraints of the functional requirements (Zhou, 2004). From these requirements, system requirements were also extracted.

4.2.2. Functional Requirements

- i. The system users (mangers and authorized parties) shall be registered by the system administrator before using it.
- ii. Authorized parties shall register lost and found persons into the system.
- iii. The searchers shall register themselves before using the system.
- iv. The developed system should allow the searchers to search for the missing friends and relatives.
- v. The system should allow the searchers to register missing persons in case they are not in the lost and found list.
- vi. The system should send notifications to the searchers in case the person previously registered as missing is added into the list of lost and found persons by the authorized parties.
- vii. The system should generate different reports when required.

4.2.3. Non-Functional Requirements

- i. The system should be reliable, timely in generating reports, efficient and secure.
- ii. The system should be easy to use for even users with basic computer knowledge, provided that they have the rights to access it.
- iii. The system should be robust.
- iv. The system should be flexible to allow future customizations.
- v. The system should be portable and should run on any device with any operating system.
- vi. Any unauthorized user should be denied to access the system.

4.2.4. System Requirements

The proposed system has the following system requirements:

a) Relational Database Management System

For easier organization and storage of data and to facilitate creating, updating, extracting and analyzing data; a central database shall be used. This system uses MySQL due to its popularity, portability and open source nature.

b) Graphical User Interface

To enhance usability, a user friendly interface shall be developed. This shall provide for conducting the search, reporting missing persons, registering lost and found persons, and extracting reports.

c) Security

To ensure data integrity, authenticity and confidentiality, user authentication shall be done before using the system. Database backups shall also automatically be run regularly to prevent data loss in case a disaster strikes.

4.3. Process Modeling

Software process model refers to an abstract representation of a software process (Scacchi, 2001). This represents a standardized format for planning, organizing and implementing a software development project. It is composed of objects, networked sequences of activities and events that entail strategies for handling software evolution.

4.3.1. Data Flow Diagram

a) Context Level Diagram

This process is handled by four categories of users namely: the searcher, authorized parties, managers and system administrator. The main process is to trace a lost child. The system administrator registers and views the authorized parties and managers. This creates credentials for logging in. The authorized parties then input the details for the lost and found persons after a successful login. The searchers then register themselves and conduct a thorough system guided search in the system. An option of adding a new missing person is also provided in case the searched person is not found. The management then views reports generated by the system. Figure 4.8 shows the context level diagram.

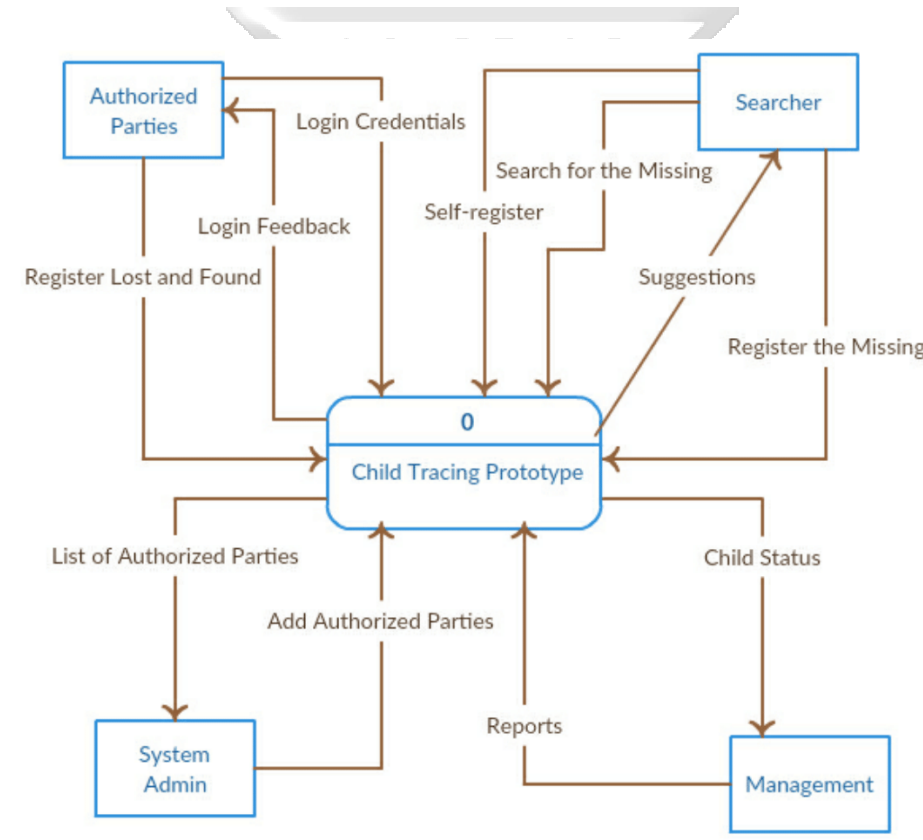


Figure 4.8: Context Level Diagram

b) Level 0 Diagram

As illustrated in the context diagram in Figure 4.8, the major processes involved in tracing a missing person/child are:

i. Managing users

The managed users include both the authorized parties and the managers. This process involves creating new users and their roles; modifying and deleting the existing users.

ii. Registration of lost and found persons

This process provides an interface to input the details of the lost but found persons. This data includes but not limited to the phenotypes; current location; the contacts of the current care giver; name, if known; and the child's photo.

iii. Self-registration

For anyone to log into this system, authentication is required. Setting up registration centers for the people with legitimate interest on a missing person is quite expensive. This means that the searchers have to register themselves. As a result, an interface for self-registration is required. Here, the searchers input their personal details plus the contact for receiving notifications.

iv. Searching for missing persons

Here is an interactive process for searching the missing person. The searchers have to log in or register, in case it is their first time before proceeding to conduct the search. The system computes the information gain for all the attributes and prompts the searcher to select among the available options of the root attribute. Information gain for the remaining attributes, keeping in mind the previous attribute, is computed. The searcher is again and again prompted to select an option among the ones presented for the attribute, among the ones remaining, with the highest information gain. This step is repeated until searched person is identified. This person is then marked as found and the search ends. Otherwise, the searcher registers the person, if not found, as explained in the registration process in (v).

v. Registration of missing persons

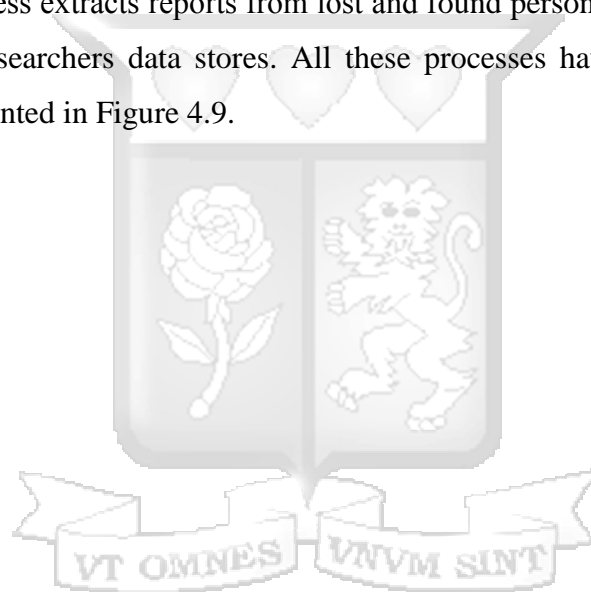
The searcher enters the details of the missing person into the system. These include the phenotypes, name and the photo of the person. The searcher is also prompted to select the preferred channel of notification (through SMS or email).

vi. Synchronizing lost and found; and missing persons

This is a background process which tries to find a match between the persons reported as missing and the ones in the lost and found list. This is triggered by an update in the list of lost and found persons by an ‘authorized party’. If similarities reach a certain threshold, a notification is sent to the searcher, requesting a search process. This then follows the search process explained in (iv).

vii. Preparing reports

The system administrator and/or the managers enter the desired report dates. This is followed a selection of the report category and sub-category, if necessary, and clicking the ‘view report’ button. This process extracts reports from lost and found persons; users; missing persons; the found persons; and searchers data stores. All these processes have been summarized and diagrammatically represented in Figure 4.9.



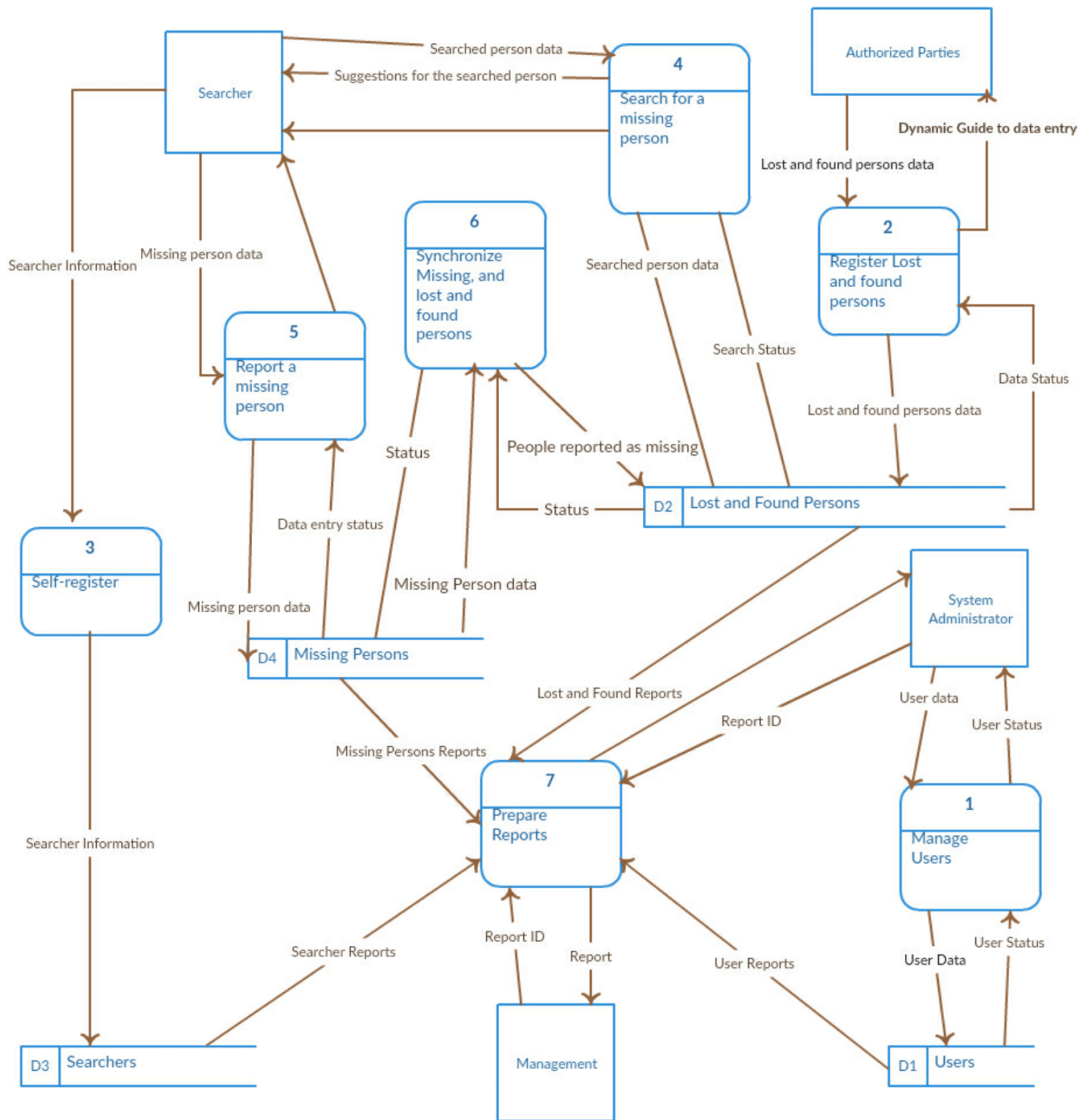


Figure 4.9: Level 0 Diagram

4.3.2. Use Case Modeling

A use case is simply a list of actions which typically define the interactions between an actor and the system with an aim of achieving a certain goal. Each interaction is a single unit of work and captures a “contract” for the behavior of the system under discussion to deliver a single goal (Kettenis, 2007). Most of the functional requirements are captured by the use case. Figure 4.10 presents a graphical representation of these interactions.

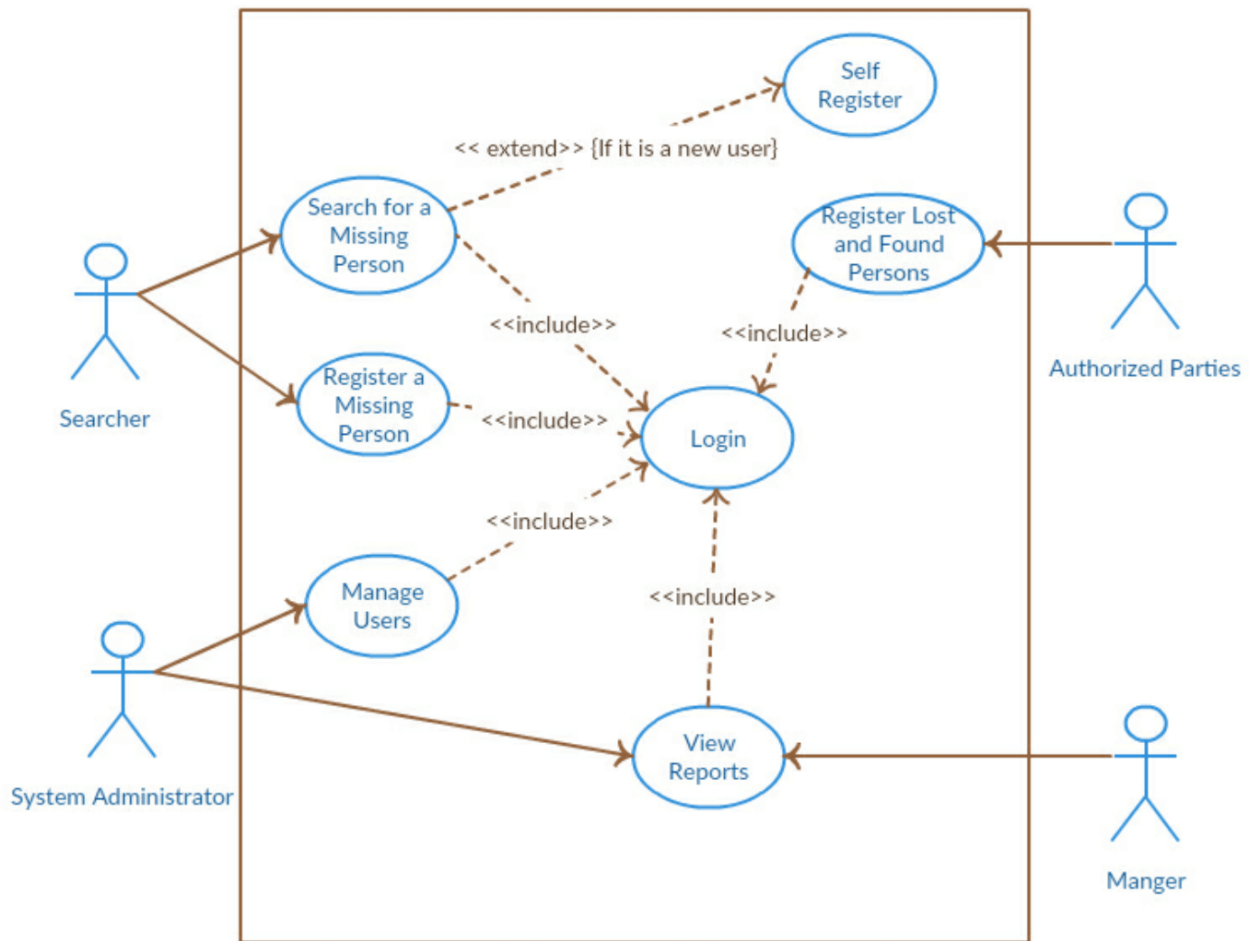


Figure 4.10: Use Case Diagram

These use case can be summarized and represented in a tabular format. Table 4.1 shows the major use cases and the actors in this system.

Table 4.1: The Main Use Cases

Actor	Use Case
System Administrator	Manage users View reports
Authorized Parties	Register lost and found
Searcher	Self-register Search for missing persons Register missing persons
Management	View reports

The first use case concerns user management. This includes registering, updating, deleted them when necessary and setting the status of their accounts as either active or inactive. This process is performed by the system administrator. Beforehand, the system administrator is required to login. User registration involves inputting the new users' personal details, their roles, their organizations and where they are located. An update requires selecting the desired user, clicking the 'edit' button, supplying updated details and clicking the 'update' button. Deletion removes the selected user from the list of users. Only the users with active accounts are allowed to login into the system hence updating this status gives or denies the user a chance to log into the system. The user management use case is shown in Table 4.2.

Table 4.2: Manage Authorized Parties Use Case

ID	UC1
Title	Manage Users
Description	Register, update and delete users
Actor(s)	System Administrator
Pre-conditions	The system administrator is logged in.
Post-conditions	Users successfully added/updated/deleted
Main success scenario	<ol style="list-style-type: none"> i. The admin enters the data for the new person; or selects the desired person and click "save". ii. In case of an update, the user click on "edit" button, enters the new data and clicks "Update".

The registration of lost and found use case works under the assumption that anyone who finds a lost child takes the child to the designated reporting point. The phenotypes of these children are entered into the system. These include: skin, eye and hair colors; availability of hitchhikers thumb, dimples, cleft chin, freckles, mid-digital hair; handedness; height; hairline

(straight or with widows peak); attached or free earlobes; ability to roll tongue; unique behavior and photo. A summary of this use case is shown in Figure 4.3.

Table 4.3: Register Lost and Found Use Case

ID	UC2
Title	Register Lost and Found
Description	Details of the missing people
Actor(s)	Authorized Parties
Pre-conditions	Authorized party successfully logged in
Post-conditions	List of lost and found persons added/updated
Main success scenario	1a. Enter the person’s details 1b. Click ‘save’ button 2a. Add additional attributes 2b. Click ‘update’ button

Self-registration is a use case for the searchers. They are required to create a personal account so that they can be able to use this system. This use case takes in the searchers personal details and contact details for further communication. Table 4.4 represents this self-registration use case.

Table 4.4: Self Registration Use Case

ID	UC3
Title	Self-registration
Description	Create a personal account in the system.
Actor(s)	Searcher
Pre-conditions	None
Post-conditions	New searcher added
Main success scenario	Account successfully created

After a successful registration and logging into this system, the searcher can now conduct the search. This involves an active interactive between the searcher and the system. The system prompts the searcher to select an option among those presented. Depending on the searcher’s choice, another attribute is chosen in accordance with its relevance. This process continues until when the searched person is found. Once found, a trigger to update the searcher person’s status to found is executed. If not found, the missing person registration use case is used. Table 4.5 summarizes this process.

Table 4.5: Search for Missing Persons Use Case

ID	UC4
Title	Search for missing persons
Description	Interactive search for persons in the lost and found list.
Actor(s)	Searcher
Pre-conditions	i. Searcher successfully logged in. ii. Lost and found persons updated
Post-conditions	Update the list of found persons
Main success scenario	Searched person found
Alternative flow of events	Register the missing persons

The registration for missing persons use case is used when the searched person cannot be identified from the list of lost and found. This demands that the searcher is logged into the system. The data entered is similar to what is entered during the registration of the lost and found. This use case is represented in Table 4.6.

Table 4.6: Register Missing Persons Use Case

ID	UC5
Title	Register missing persons
Description	Registration of persons whose whereabouts cannot be traced.
Actor(s)	Searcher
Pre-conditions	i. Searcher successfully logged in ii. The searched person is not in the list of lost and found.
Post-conditions	The list of missing successfully updated
Main success scenario	Missing person successfully added.

The use case for viewing reports is accessible by both the system administrator and the managers. However, the managers cannot extract reports on user management. Both the system administrator and the manager view reports on the persons reported as missing; lost and found; and those found. In addition, the duration taken to trace the person is also extracted. In order to generate a report, one has to select the main category in which the desired report is found. This is followed by an optional selection of a sub-category. Date selection is also optional and therefore can be ignored. Once done, a 'download' option is availed to the user. The use case for viewing reports is shown in Table 4.7.

Table 4.7: View Reports Use Case

ID	UC6
Title	View Reports
Description	Reports on: <ol style="list-style-type: none"> i. Missing persons. ii. Lost and found persons. iii. Found persons iv. User management
Actor(s)	Management and System Administrator
Pre-conditions	<ol style="list-style-type: none"> i. User successfully logged in. ii. Missing persons updated iii. Lost and found persons updated iv. Lost persons traced
Post-conditions	Detailed reports extracted.
Main success scenario	<ol style="list-style-type: none"> i. The user selects the report category ii. The user then selects the report sub-category iii. The user enters the desired duration iv. The user clicks on 'view report' button. v. The user downloads the report (optional)

4.3.3. Sequence Diagram

The sequence diagram in this case provides a visual representation the object interactions during the searching process. This includes the actor and the objects the actors interact with throughout the execution of the search.

The searcher initiates the process by executing the 'trace person' action. This is then followed by a loop where the searcher selects from a list of dynamically displayed phenotypes which narrow down from a wider to a focused view depending on their entropies. This process repeats until when the searched person is found. The searcher then selects the person and ends the search process. This marks the person as found and is followed by an automatic update of the list of found persons.

If the searched person was not found, the searcher enters the details of the searched person. This registration process prompts the searcher to provide the contact through which, if the person is found, a notification will be send through. After this, any subsequent registration of lost and found persons trigger synchronization of the list of the missing persons and those reported as lost and found. In case there is a close relationship between the searched person and

the one entered, a notification is automatically send to the searcher, prompting him/her to conduct another search. These interactions are summarized in Figure 4.11.

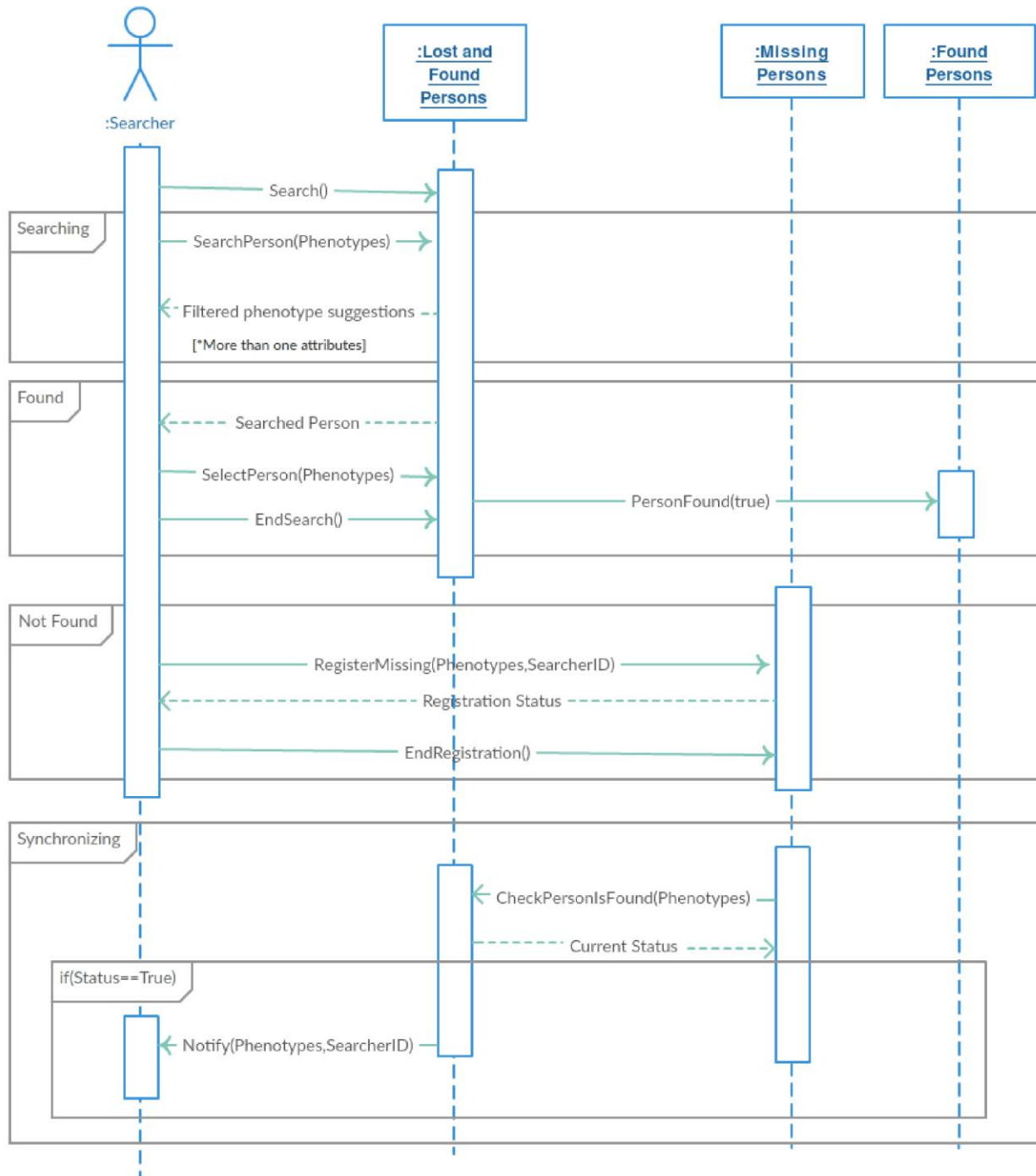


Figure 4.11: The Search Process Sequence Diagram

4.4. Control Modeling

4.4.1. Entity Relationship

An entity relationship model is a high-level conceptual model which describes data in terms of entities, their attributes and their relationships (Riccardi, 2002). The entity relationship diagram shows how is represented and organized in the database schema without specifying the actual data (Pagh, 2006).

The system administrator has the user id attribute as the primary key. The relationship between the system administrator and the user is one to many. This shows that one system administrator can manage more than one entity user.

The user entity has username attribute as the primary key. The entities manager and authorized party borrow attributes from user. These borrowed attributes include name, username and password. The two have “ISA” relationship with the entity user. In addition to these attributes, authorized party entity has location and organization attributes.

Lost and found persons have several phenotype attributes which describe them. The relationship between the authorized party entity and the lost and found entity is a many to many relationship. This means that one or more authorized parties can register one or more lost and found persons. Just like the lost and found entity, the missing person entity has phenotype attribute which describe it. The searcher entity has username, password, phone number and name as the attributes. Username is the key attribute. The name attribute is multivalued as it can take several values. There exists a many to many relationship between the searcher and the lost and found entity. This means that one or more searchers can search for the same or different lost and found persons. A similar relationship exists between the searcher and the missing person entity which means that one or more searchers can register one or more missing persons.

Entity report has date, details and report id as its attributes. The report id is the primary key. Considering the relationship between entities system administrator and report, one system administrator can view one or more reports. One or more managers can also view one or more reports. As shown in the one to many relationship.

Figure 4.12 illustrates how entities in the child tracing prototype interact with each other.

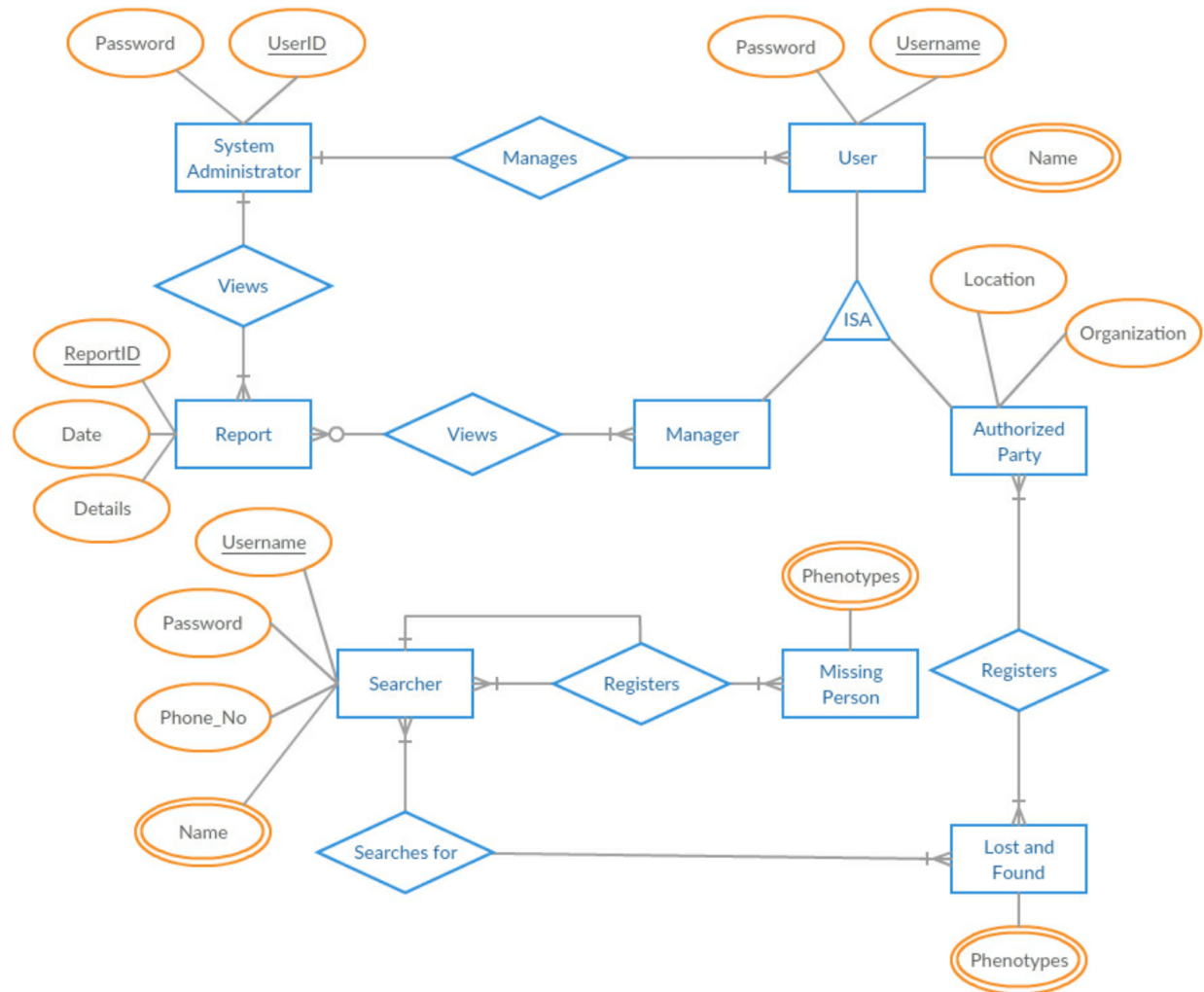


Figure 4.12: Entity Relationship Diagram

4.4.2. Class Diagram

A class diagram provides a pictorial representation of all the classes in an object oriented system; their attributes and methods; their connections; their interactions and inheritances if any. In simpler terms, classes represent objects whose roles are similar and to what extend the objects of the classes “know” about each other (Felici, 2011).

The system administrator can login, add one to many new users, modify the existing and log out. The system administrator can also view one or more reports. Managers and authorized parties are both users. They inherit attributes; and login and log out functions from the superclass “user”. In addition to the inherited functions, one or many managers can view zero or more

reports while one or many authorized parties can register zero or more missing persons. A searcher on the other hand can login; search one or more lost and found persons; register zero or more missing persons and log out. The search functionality is discussed in depth in section 4.5.3. This is illustrated in Figure 4.13.

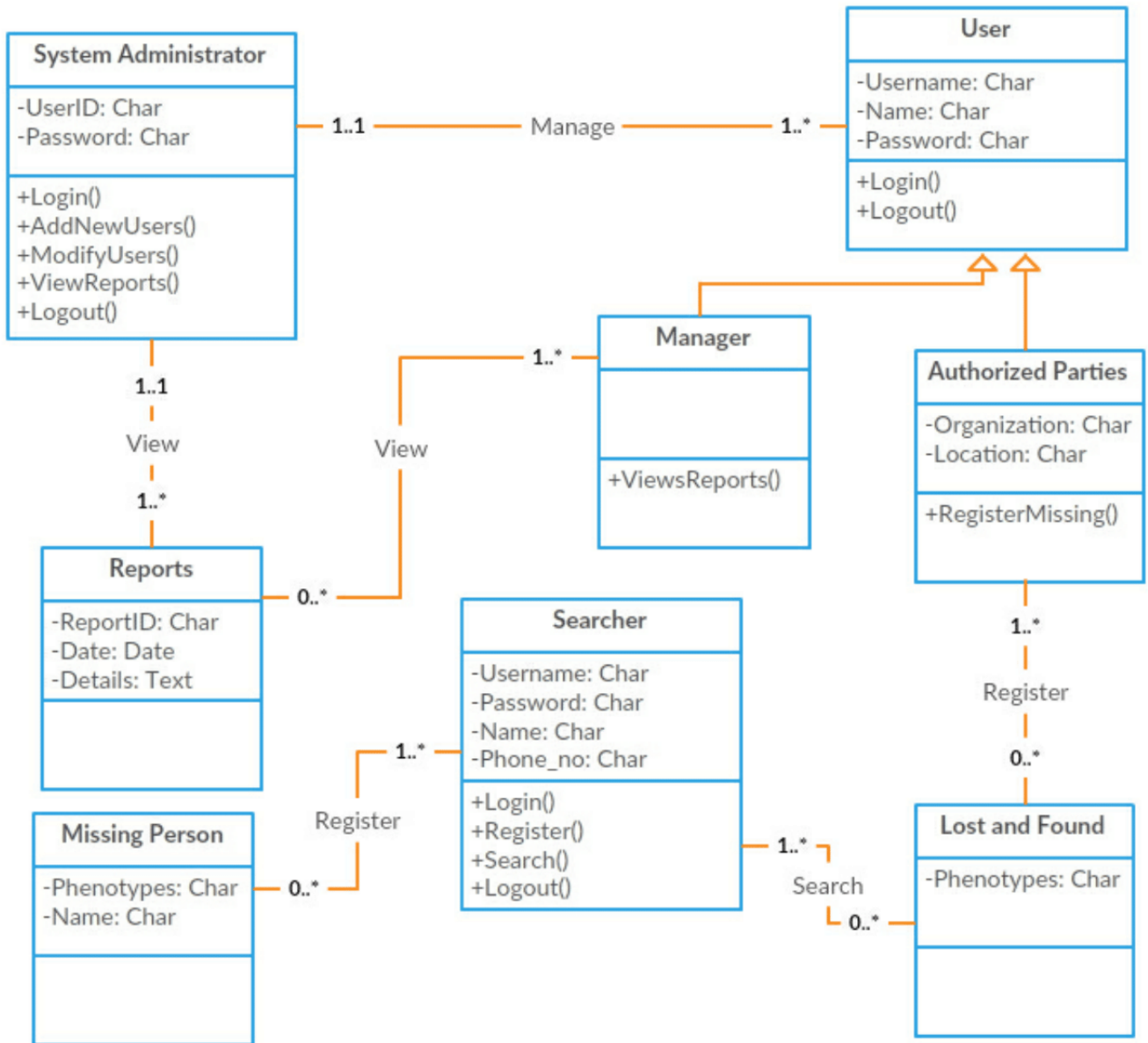


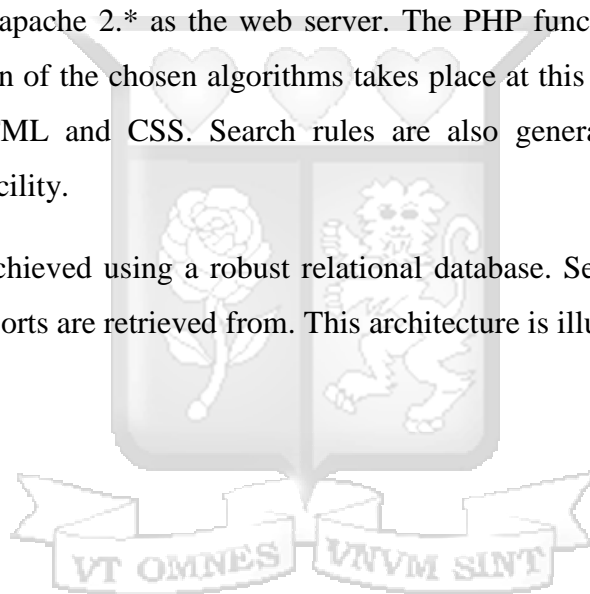
Figure 4.13: Class Diagram

4.5. The Prototype Architecture

The architecture for this prototype is divided into four major components. These include the user interface, the internet/intranet/extranet access, application server and the database server. The user interface is accessible using a web browser. These are the interfaces through which the users can interact with the system. These are open to any standard browser such as Mozilla Firefox, Google chrome, internet explorer and opera among others. The internet access offers the channel for data transfer from the client browser to the server side. For this case, the extranet is used to provide a secure connection for the authorized organization. Standard protocols like TCP/IP are used here.

The system uses apache 2.* as the web server. The PHP functions are executed at this level. The implementation of the chosen algorithms takes place at this stage and rendered to the user interface using HTML and CSS. Search rules are also generated at this point in the knowledge acquisition facility.

Data storage is achieved using a robust relational database. Set functions here generate views from which the reports are retrieved from. This architecture is illustrated in Figure 5.2.



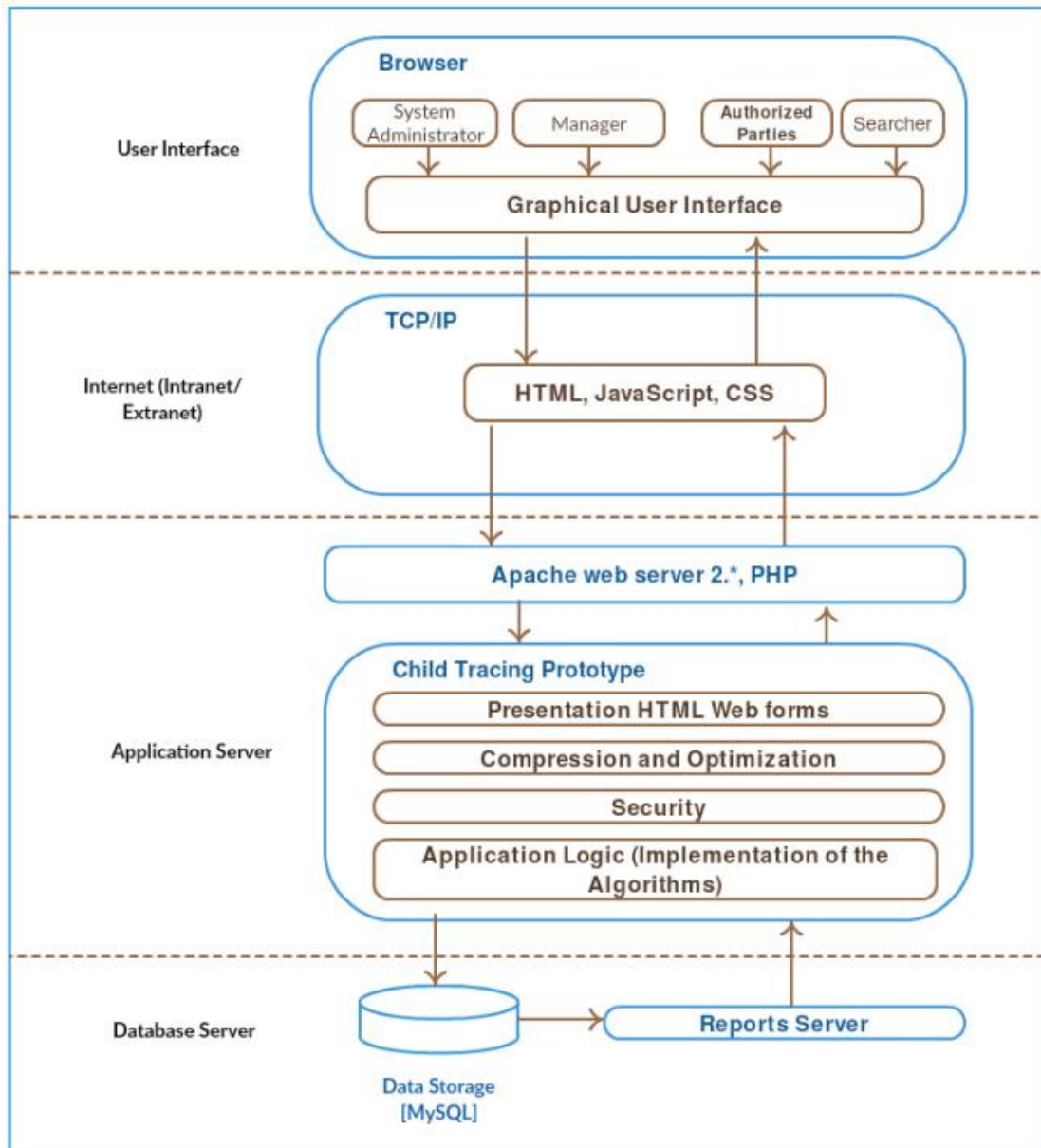


Figure 4.14: Child Tracing Prototype Architecture

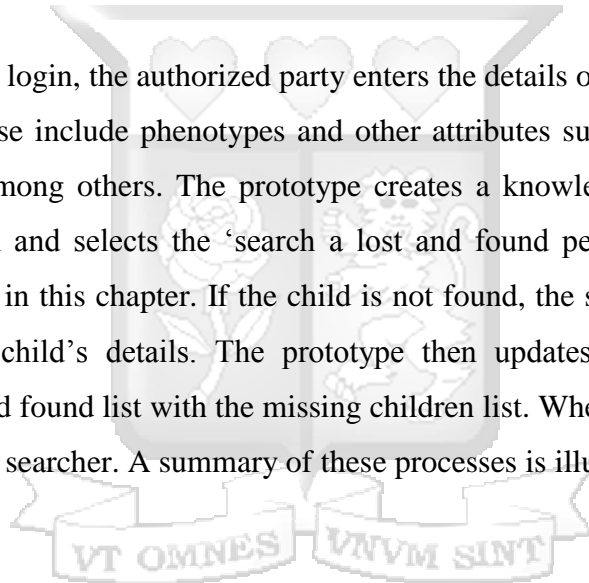
Chapter 5: System Implementation and Testing

5.1. Introduction

Using the design in chapter 4, the prototype was implemented and tested. The prototype was developed using PHP, HTML, CSS, JavaScript, Ajax and MySQL database. In this case, PHP is used to execute the logic. This includes generating the knowledge base and computing the entropy during the search process. HTML and CSS are quite useful in presentation of the prototype. Ajax and JavaScript are used for validation and ensuring that the system is dynamic. MySQL database is used to store the data and the knowledge base generated. Testing for the main functionalities was also carried out.

5.2. Program Flow

After a successful login, the authorized party enters the details of the lost and found child. As explained earlier, these include phenotypes and other attributes such as name, age, a photo and languages spoken among others. The prototype creates a knowledge base from this data. When a searcher logs in and selects the ‘search a lost and found person’, the search process begins as explained later in this chapter. If the child is not found, the searcher is presented with an option to enter the child’s details. The prototype then updates its knowledge base by synchronizing the lost and found list with the missing children list. Whenever a match is found, a notification is send to the searcher. A summary of these processes is illustrated in Figure 5.1.



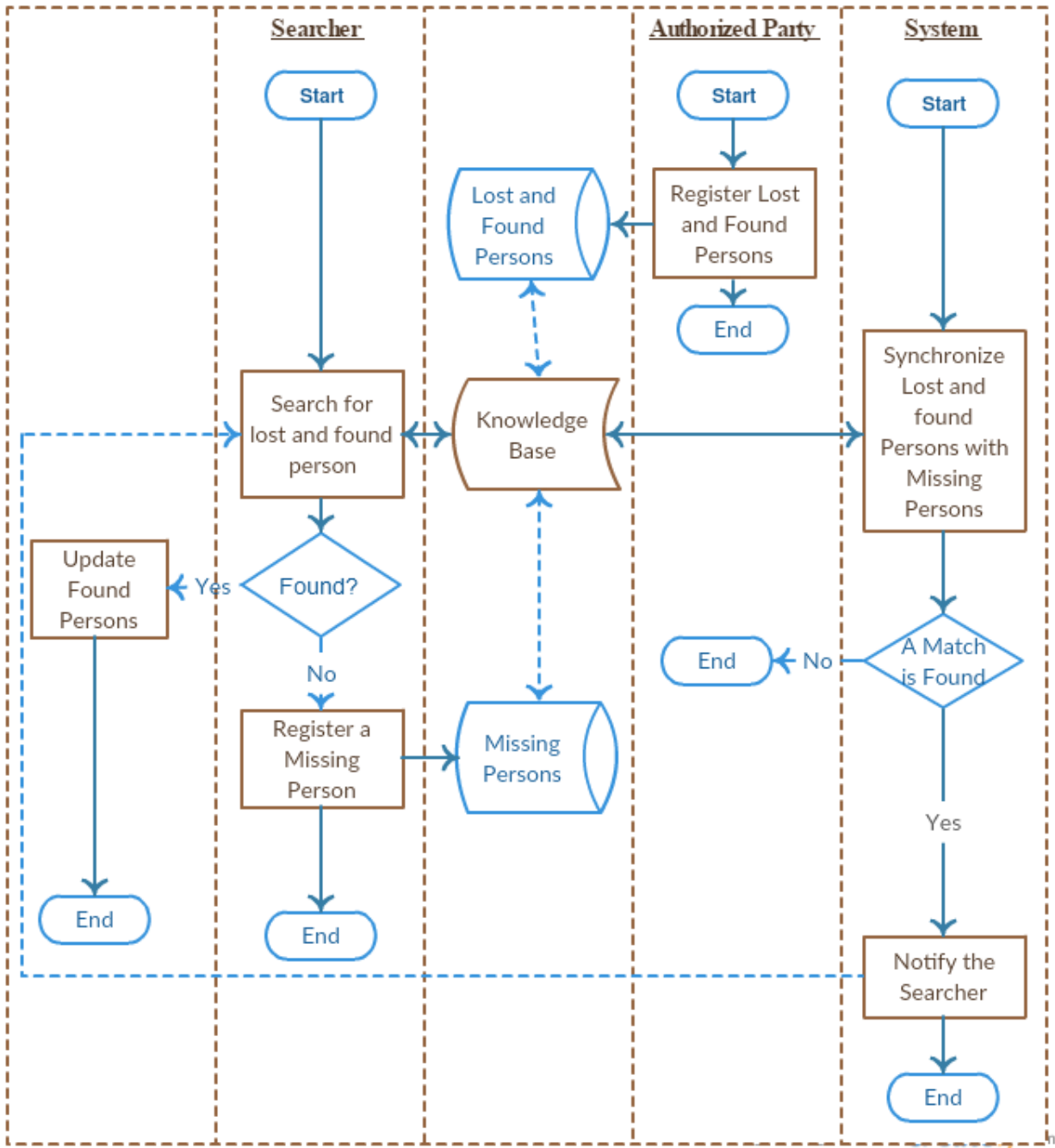


Figure 5.1: Program Flow

5.3. Server Requirements

5.3.1. Hardware Requirements

Table 5.1: Hardware requirements

Hardware	Minimum Requirements
Processor	Intel Core
Cycle speed	200MHz
Hard Disk Space	15GB

5.3.2. Server Software Requirements

Table 5.2: Software Requirements

Software	Minimum Requirements
Server operating system	Any Linux flavor, Windows 2000/2008 Server/XP/NT
Client Operating System	Any Linux flavor, Windows XP/Vista/7/8/10
Web Server	Apache 2.0+
Web Browser	Mozilla Firefox 3+, Internet Explorer 6+ Chrome, Opera
Database Management System	MySQL 5.0+

5.4. Users, Roles and Access

The system was designed to have a role based access. This led to creating four user roles namely: the system administrator, authorized users, managers and the searchers.

5.4.1. Searcher

For a first time searcher, registration is required. Subsequent users are required to authenticate themselves before using the system. Searchers have two major roles: searching for their lost and found friends and relatives; and registering the missing ones. This category of users can also subscribe to receive SMS or email notifications as soon as a person similar to the one they registered as missing is added into the list lost and found persons by the authorized parties.

5.4.2. Authorized Party

This interface is accessed through a web portal and requires user authentication. The authorized party enters a list of lost and found persons and their current locations. They can also update the persons in case some of the attributes change. These may include age and current location among others. They can also view reports on all the lost and found people, how long they have been kept and shifting of their locations over time.

5.4.3. Managers

This role requires user authentication and is also access via the web portal. The main function here is to view reports on the numbers of missing persons; the lost and found persons; and the found persons. Above all, the managers can search for the missing, register searchers, update the list of missing persons, and add lost and found persons.

5.4.4. System Administrator

The system administrator was responsible for registering managers and authorized parties. The authorized parties included the police in designated police posts, some Kenya Red Cross Society officials in designated stations, and some care givers in designated children's homes. This user logs into the system and opens the interface to perform the previously discussed task. This access is directly through a web portal. The system administrator also views reports on: the number of registered 'authorized parties', searchers and managers; the missing persons; the lost and found persons; the found persons; and the average duration taken to trace a missing person.

In addition, this user has access to the roles of the authorized parties, managers and searchers. This means that the user can add lost and found persons, register missing persons, create searchers and search for the missing person on behalf of a legitimately interested searcher.

5.5. The Pseudo-code

The major functions in this prototype are the dynamic search and the self-synchronization. At the start, the prototype creates a list of all the attributes. These include both phenotypes and the other attributes. Entropy for these attributes is computed and the root attribute chosen. The options of this root attribute are then presented to the searcher for selection. The searcher then submits the selection. Based on this selection, the prototype trims the attribute

list and computes the entropy of the attributes in the new list. The attribute candidate is chosen and its options presented to the searcher for selection. This process repeats until either, a match is found or the matching attributes have been exhausted. If the later happens, the prototype informs the searcher that a match could not be established and prompts him/her to register the missing person. This pseudo-code is shown in Figure 5.3.

```
attribute_list={phenotypes,other_attributes};
While(searching){
    compute_entropy(attribute_list);
    display_attribute_with_the_highest_entropy_to_the_searcher();
    get_the_selected_option_from_searcher(attribute_id);
    trim_the_list(attribute_list,non_matching_attributes);

    if(person_is_found){
        end_search();
        update_found_persons_list();
    }

    if(attribute_combination_does_not_lead_to_any_person_in_the_lost_and_found_list)
        register_the_missing_person(phenotypes,other_attributes);
}
}
```

Figure 5.2: The search Process Pseudo-code

The prototype keeps on performing background synchronization whenever the list of lost and found persons is updated. If a match is established, the prototype searches for the contact information of the involved searcher. A notification to the searcher is then send, prompting him/her to perform the search process again. This is shown in Figure 5.4.

```
find_match_between_missing_and_lost_and_found_persons();
if(match){
    get_searcher_contacts();
    send_notification(searcher_id,phenotypes,other_attributes);
}
```

Figure 5.3: Synchronizing missing and lost and found lists

5.6. Sample Forms Used

To provide an interaction between the users and the prototype, several interfaces were built. Each interface represented a unique task or sub-task. These are user management, registration of the missing persons and searching for the missing person among others.

5.6.1. User Management

This interface provided a convenient way of registering, displaying, modifying and deleting system users. The system administrator enters the details of the users and clicks “Save Data” button. The prototype validates the data fields to ensure that they are in the correct format before being saved into the database. A list of all the registered users is also displayed. The key attributes displayed include the user id, name, the organization in which the user works in, role and edit/delete option. Clicking the “Edit” icon loads the data into the new user form ready to be edited. After editing, the system admin click the “Save Data” button to update the changes. Clicking the “Delete” icon prompts the user to confirm the deletion. Once confirmed, the delete query is run against the user’s id in the database. The user management interface is shown in Figure 5.5.



The figure displays two parts of the user management interface. On the left is the 'New User' form, and on the right is the 'All Users' table.

New User Form:

- Name: First Middle Last
- Phone: Include the country code
- Email: xxxxxxxx@xxxx.xxx
- Gender: Female Male
- Role: Select one
- Organization: Select one
- Save Data button

All Users Table:

Id	Name	Role	Organization	Phone	Email	Action
1	xxxxxxxx	xxx	x1x1x1	(254) xxx xxx xxx	xxxxxxx@xxxx.xxx	 
2	yyyyyyyy	yyy	y1y1y1	(254) yyy yyy yyy	yyyyyyy@yyyyy.yyy	 
3	zzzzzzzz	zzz	z1z1z1	(254) zzz zzz zz	zzzzzzzz@zzzz.zzz	 

Figure 5.4: User Management

5.6.2. Registering a Lost and Found Person

Once the authorized parties find a missing person, they can enter the details in the “lost and found persons” interface. Among the bio-data capture include the name, gender, photo, contact address on where the person is residing, languages spoken and the phenotypes. The name is optional since the person may not remember his/her name in case of a little child or a mentally challenged person. More bio-data fields and the “save” button can be found after expanding the bio-data interface by clicking the “More Bio-data” button. Some phenotypes like the skin color among others prompt the person entering the data to select the attribute value (color) from a range provided. This is to ensure that confusion is minimized in case someone is not sure about the color names. To avoid page cluttering, a few phenotypes are displayed at a time. The others can be seen on clicking the “More Phenotypes” button. This process is summarized as shown in Figure 5.6.

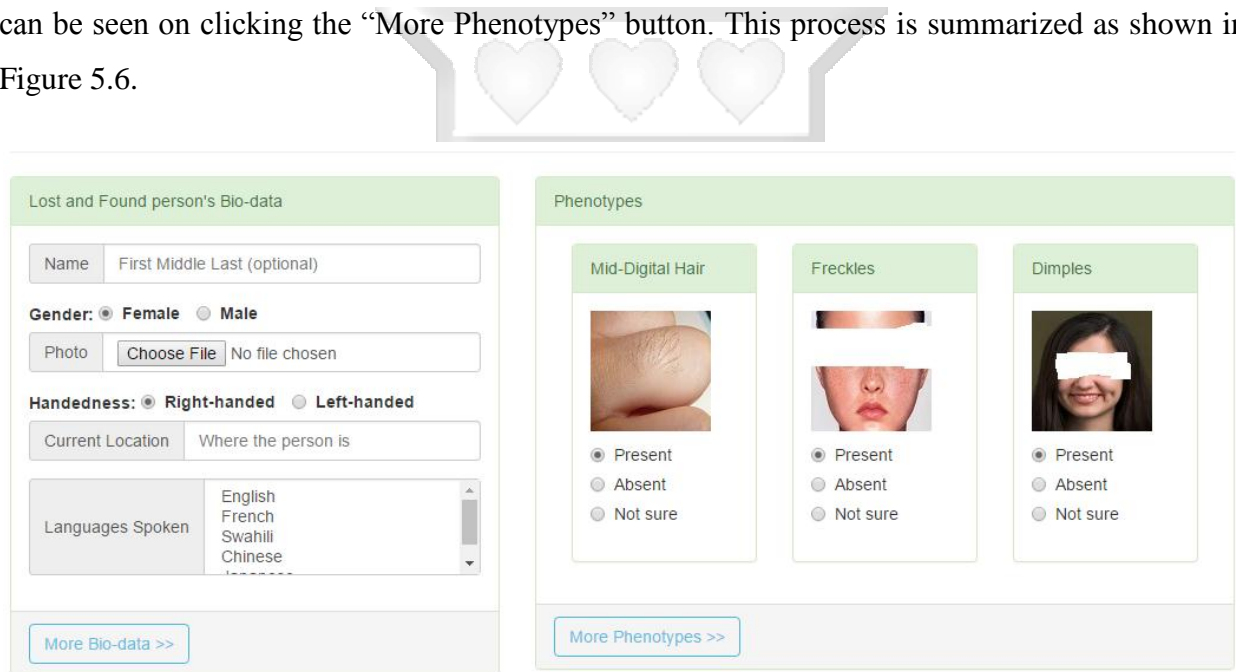


Figure 5.5: Registering a Lost and Found Person

5.6.3. Searching for a Missing Person

The key functionality of this prototype is the “search”. This involves an iterative computation of the information gain for the remaining attributes. The key attributes are displayed one by one. These require the searcher to select an option among the ones provided. The selected attributes are then combined to determine the next attribute as earlier discussed. For attributes whose responses might be confusing especially to the searcher, images are provided for clarity. These include skin complexion, hairline, hair color and texture among others. This process loops

through the key attributes and later presents a list of related photo(s) for confirmation. The search process is shown in Figure 5.7.



Figure 5.7: The search process

The chosen attributes are stored in a session. These are then displayed on a table as shown in Figure 5.6. This display helps the searcher cross-check the attributes. In case a wrong value has been selected, the searcher can easily identify it and reset the search by click the “Reset the Search” button as shown in the same figure.

The image shows a table titled 'Selected Attributes/Phenotypes' with a 'Reset the Search' button in the top right corner. The table contains four rows of data:

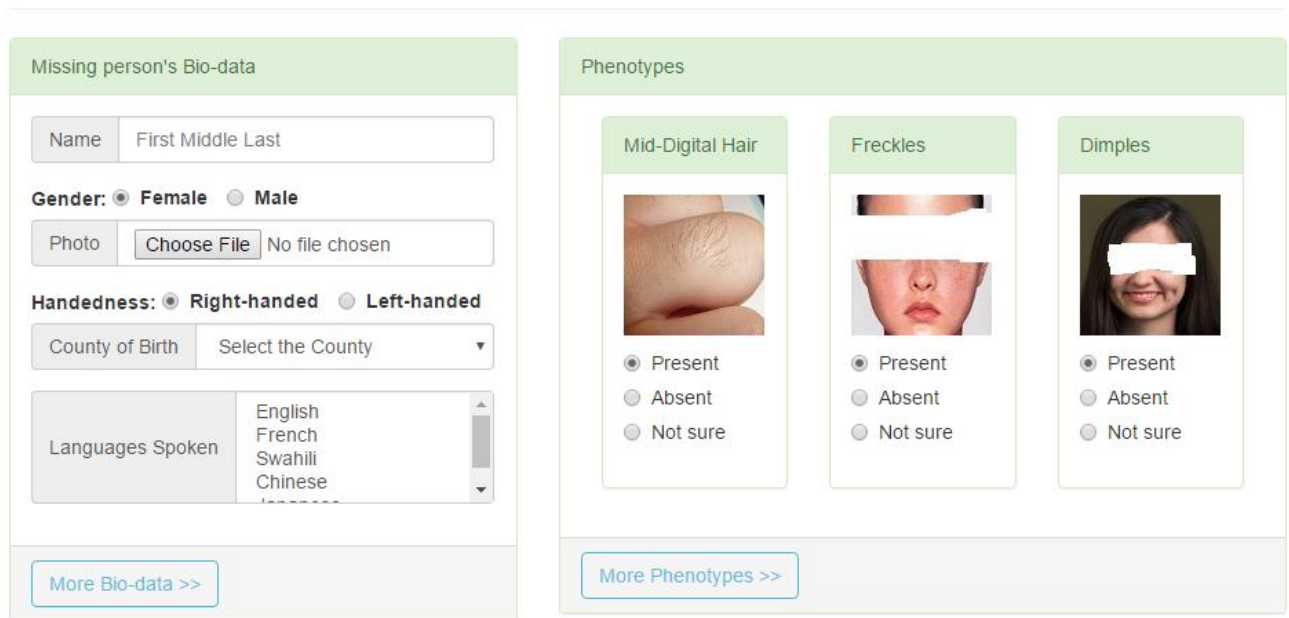
#	Attribute	Value
1	Freckles	Present
2	Dimples	Present
3	Handedness	Right
4	Can Roll Tongue	Yes

Figure 5.6: Searching for a Missing Person

5.6.4. Registering a Missing Person

When the person is not in the list of lost and found persons, his/her details will not show. The searcher is therefore provided with an option of entering the details of the missing person. These include the name, gender, county of birth and several phenotypes. The bio-data fields are compulsory since they contain the basic details for the searched person and therefore the searcher is expected to have them in his/her fingertips.

The phenotype combinations provide a quicker way of narrowing down the matching process which is done by the system whenever a lost and found person is added. More bio-data fields for the missing person can be displayed by clicking the “More bio-data” button. Clicking on the “More Phenotypes” displays the next page of the phenotypes. When all the required fields are correctly filled and attribute options selected, a “save” button appears. Clicking on this button updates the missing person’s records in the database. Figure 5.8 summarizes the process of registering a missing person



The image shows two side-by-side web forms for registering a missing person. The left form, titled "Missing person's Bio-data", includes fields for Name (First Middle Last), Gender (Female/Male), Photo (Choose File), Handedness (Right-handed/Left-handed), County of Birth (dropdown), and Languages Spoken (list: English, French, Swahili, Chinese). The right form, titled "Phenotypes", features three columns: "Mid-Digital Hair" with a fingerprint image, "Freckles" with a face image, and "Dimples" with a face image. Each column has radio buttons for "Present", "Absent", and "Not sure". Both forms have "More Bio-data >>" and "More Phenotypes >>" buttons at the bottom.

Figure 5.7: Registering a Missing Person

5.7. Prototype Validation

The prototype had an error checking facility which could validate the user input. This dynamic validation was usually using JavaScript. Error messages were displayed accordingly so as to inform the user about what has gone wrong and offer a guide on how to resolve it. Among the fields validated included the username and the password in the login interface. Leaving out either the username/password or both would prompt the user to enter them as shown in Figure 5.9.

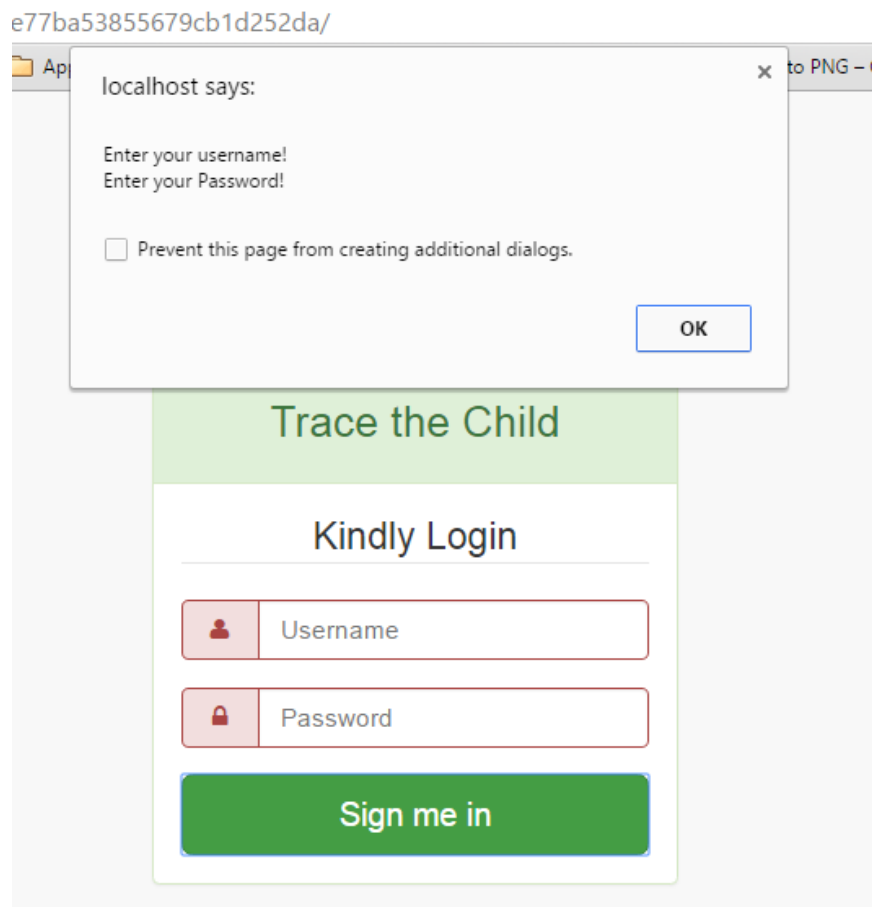


Figure 5.8: Prototype Validation (Username/Password Missing)

Whenever unsuccessful login attempt was made, the prototype would log the attempt details (username and time stamp) in the database. These logs are viewed by the system administrator. A failed login attempt would therefore display an error to the user. This is illustrated in Figure 5.10.

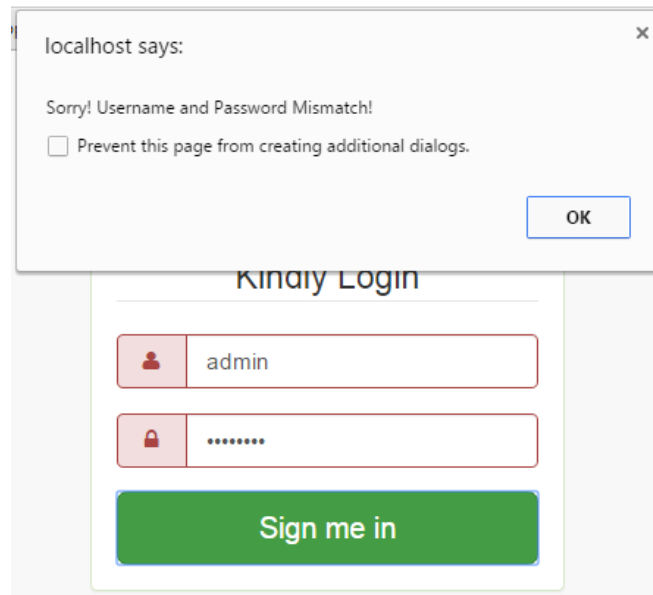


Figure 5.9: Username and Password Mismatch

5.8. Prototype Testing

System testing is the process examining the behavior of the developed system based on the system requirements specifications (Faisandier, 2012). To ensure that the prototype meets the user requirements provided, several tests were done. Some of the tests done are shown in Table 5.3.

Table 5.3: Test Cases

ID	Case	Expected Outcomes	Comments
1.0	Login		
1.1	Password or username left out	Error Dialog Box	Pass
1.2	Wrong password or username entered	Error Dialog Box	Pass
2.0	User Registration		
2.1	Leaving out a required field	Error Dialog Box	Pass
3.0	Lost and Found Person Registration		
3.1	Leaving out a required field	Error Dialog Box	Pass
4.0	Searcher Registration		
4.1	Leaving out a required field	Error Dialog Box	Pass
5.0	Missing Person registration		
5.1	Leaving out a required field	Error Dialog Box	Pass
6.0	Role Access		
6.1	Accessing unauthorized Page	Session destroyed. User redirected to the login page	Pass

5.9. Prototype Maintenance

The prototype shall later be developed into a fully functional system with other additional modules. Enhancements shall be done to ensure that it is very robust, scalable and adaptability to software and hardware platforms of different devices. Time to time maintenance shall also be done to match change user needs.



Chapter 6: Discussions

6.1. Introduction

After developing the prototype, tests had to be done in order to understand how the target users felt about it. The same group of respondents through which user requirements were collected was the same group used to test this. The respondents were trained on how to use it. Their feedback was then collected using a questionnaire and summarized using pie charts.

6.2. Findings

6.2.1. User Interface

With regard to the user interface, 46% of the respondents strongly agreed that the graphical user interface was very friendliness. 36% agreed, 10% were neutral about it, 6% disagreed and 2% strongly disagreed that the interface was very user friendly. This is illustrated in Figure 6.1.

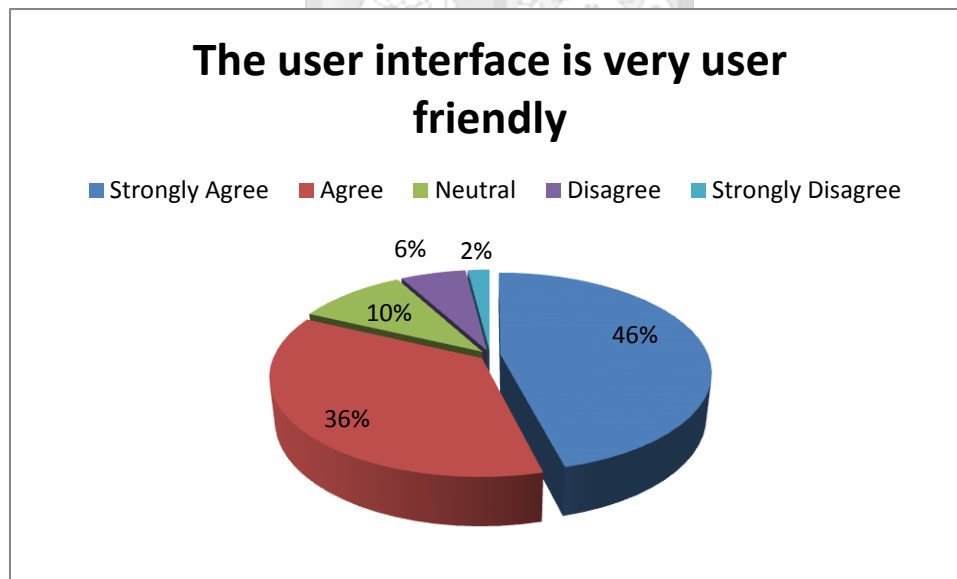


Figure 6.1: User friendliness of the Prototype

54% of the respondents strongly agreed that they were capable of using the prototype with minimum training since they said that it was straight-forward. 36% agreed, 8% were neutral, 2% disagreed and none strongly disagreed with this statement. This is illustrated in Figure 6.2.

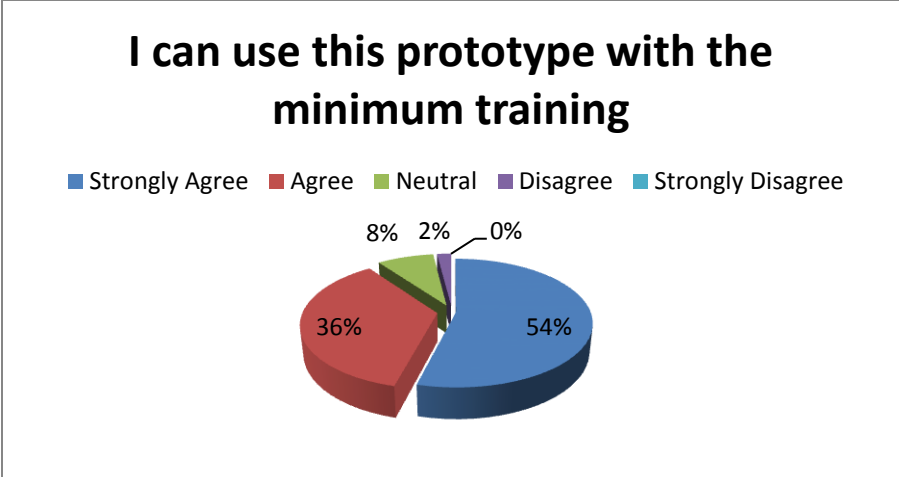


Figure 6.2: Ease of usage of the prototype

6.2.2. Performance

Police brand the investigations into complaints of missing persons as “Searching for a black cat in a dark room” (Nadu, 2011). This is because of the defragmented information residing in different child protection agencies. This means that the time range may be indefinite even if the child sought is residing a registered Children’s Home.

Contrary to this, 30% of the respondents strongly agreed that searching with this prototype would take a shorter duration as compared to the existing methods. 20% agreed, 20% were neutral, 18% disagreed and 12% strongly disagreed with this claim. This is summarized in Figure 6.3.

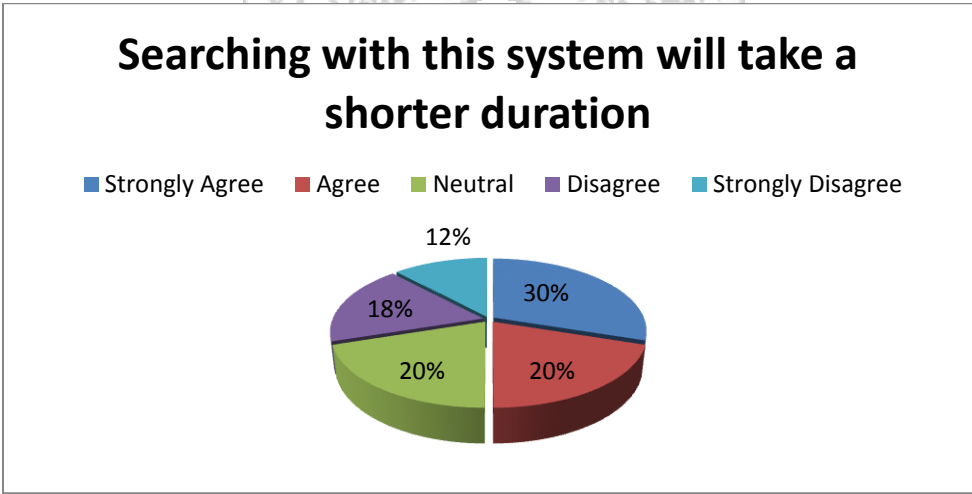


Figure 6.3: Performance of the Prototype

6.2.3. Accuracy

The respondents provided five dummy data items of lost and found children to the respondent who then keyed them into the prototype. They then searched through the data to check if they would get accurate results. The results showed that 99% of the data (dummy children) searched gave the expected outcomes. 1% was gave a different outcome. Figure 6.4 shows these results.

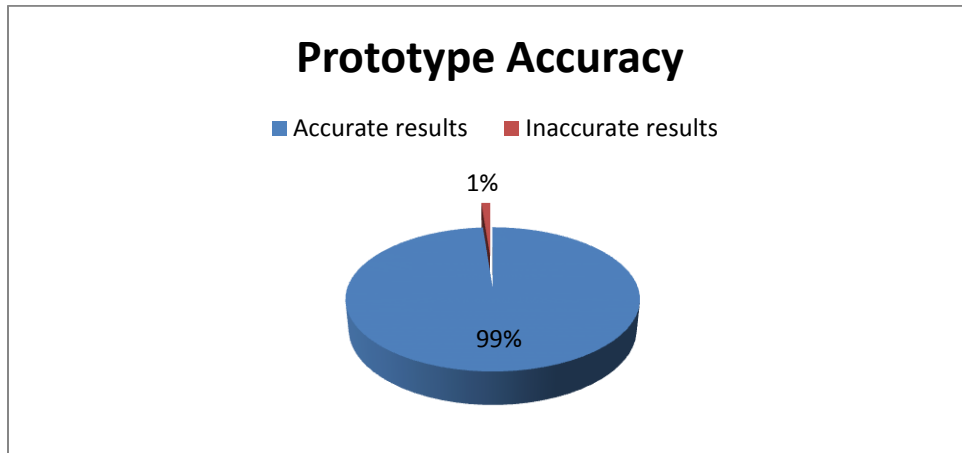


Figure 6.4: Prototype Accuracy

6.2.4. Convenience

Concerning the convenience of the prototype, 70% of the respondents strongly agreed, 24% agreed, 4% were neutral and 2% disagreed that it was very convenient. This is shown in Figure 6.5.

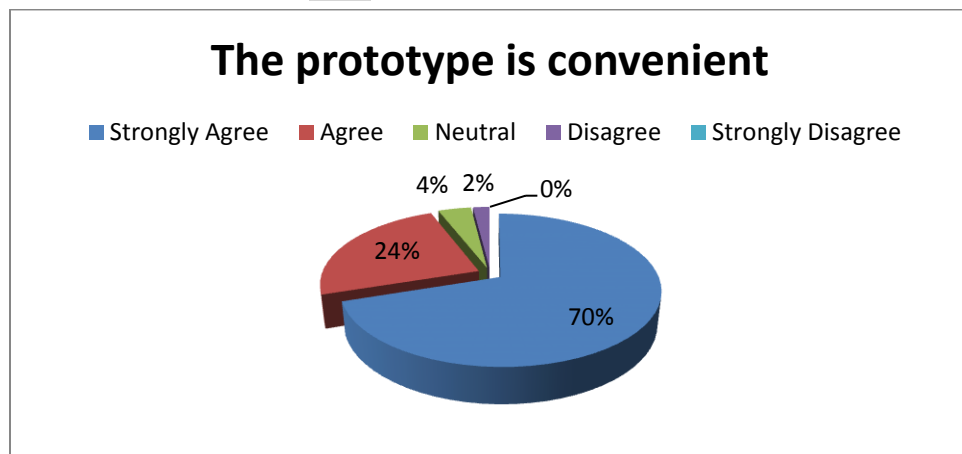


Figure 6.5: Prototype Convenience

6.2.5. Reliability

To test the reliability of the prototype, respondents' willingness to use the system and recommend others to use it was checked. 58% of them strongly felt that they would use this prototype in case any of their loved ones went missing. 30% were willing to use it, but with lesser liking, 10% were not sure (neutral), 2% were not willing to use it in future and none of them was strongly against using it in future. Figure 6.6 summarizes this information.

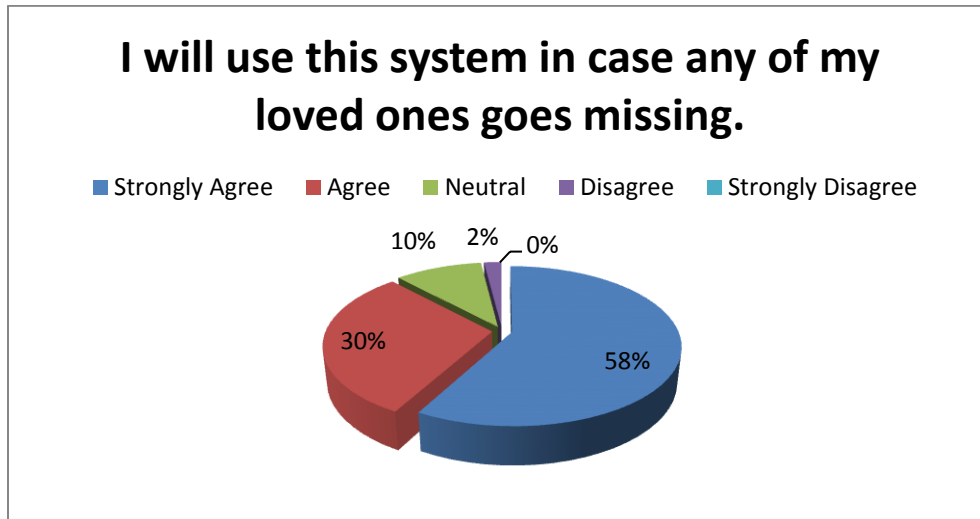


Figure 6.6: Prototype Reliability

In social media data is usually fragmented by source (Moorhead, Hazlett, Harrison, Carroll, Irwin, & Hoving, 2013). In addition, it is hard to capture feedback from these social media especially when the data sent has no way of mapping to the original source. This includes information forwarding in channels like WhatsApp among other media. This prototype is more reliable since it has a central database where different relevant reports can be extracted from. Social media also provides for anonymity (Xiang & Gretzelb, 2010). This allows for information distortion or submission of unverified information which may cause unnecessary panic.

Recommending the prototype to the others returned the same results as the willingness to use the prototype in future. 58% strongly will to recommend others to use this prototype, 30% said that they would recommend it, 10% were not sure and 2% were not willing to offer the recommendations. This is shown in Figure 6.7.

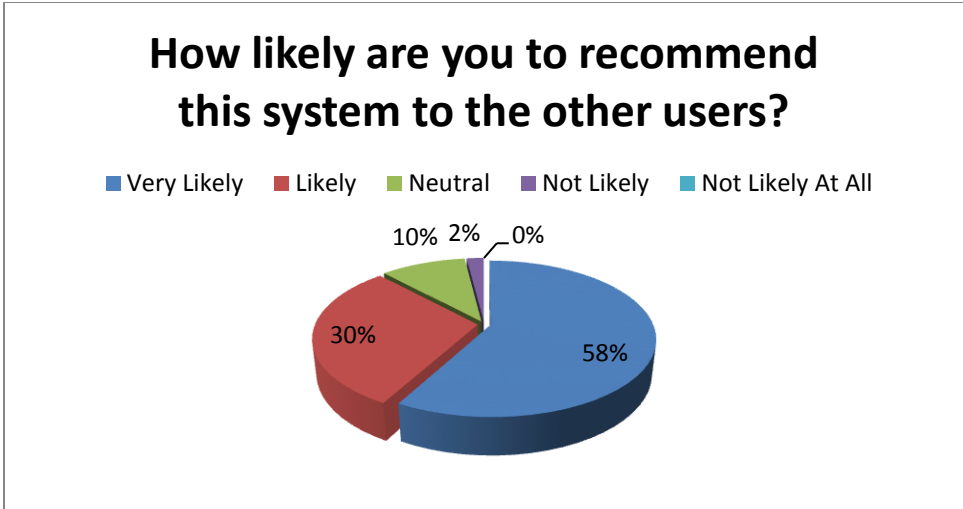


Figure 6.7: Prototype Recommendation to others

6.3. Limitations of this Prototype

Through this study, the researcher noted that public lacked awareness on the process of tracing a missing child. This prototype however, does not address this issue. Among the challenges faced in reuniting the lost and found with their parents was that some parents abandon their children and request for a reunion years later when the children have grown up. They produce fake evidence on the circumstance through which the child disappeared. This prototype does not have a mechanism of verifying the evidence given.

Chapter 7: Conclusion and Recommendations

7.1. Conclusion

Tracing missing children has been a cumbersome task. Most people in Kenya use the social media to pass the information concerning the lost loved ones and the lost and found ones. The information from these sources lack credibility as anyone can author anything and pass it to multitudes. The Red Cross Society also faced this challenge especially after a crisis when trying to reunite displaced people with their loved ones. Their approach has no mechanism for a searcher to remotely search the missing person except through the phone or physically visiting their set tents. This is quite tedious hence the call to a well-integrated system offering an interactive search a missing loved one.

As highlighted in the questionnaires, most of the members of the public find the current process of tracing missing persons very tedious. The police also depend on the public for information concerning lost and found children. When some well-wishers find a lost child, they usually take the child to a children's home or even other keep the child hence making it harder for the parents to trace the child.

This research takes advantage of machine learning algorithms to bring out a mechanism through which missing children can be easily traced. In addition, the research makes it much easier for a searcher to identify the sought from the list of the lost and found children by filtering the attributes hence narrowing the search. Searchers can also be notified whenever a child similar to what they registered is missing is identified by the system. This is through attribute matching in the list of lost and found, and the one of the missing children.

7.2. Recommendations for Further Research

Each person has unique biometric features. This means that mapping these features to the primary care giver would be useful. The researcher recommends a scenario where after a child is born, these features are collected, together with their parents'/guardians' contacts details, and stored in a central database managed by the state. Having the database in the hands of the state can enhance security and authenticity of the data. Special scanners may be present in all private and governmental child protection agencies such as the Red Cross Society, designated Police

Stations and Children's Homes among others. Whenever a lost and found child or rather person is reported, this approach should provide a way of contacting the person's primary care givers.

Other recommendations are:

- i. Introduction of Radio Frequency Identification (RFID) gadgets to children would assist in capturing and saving the child's data into the system hence making the process much easier.
- ii. How Geographical Positioning System (GPS) could be applied to locate a missing child without exposing his/her information to the wrong hands.



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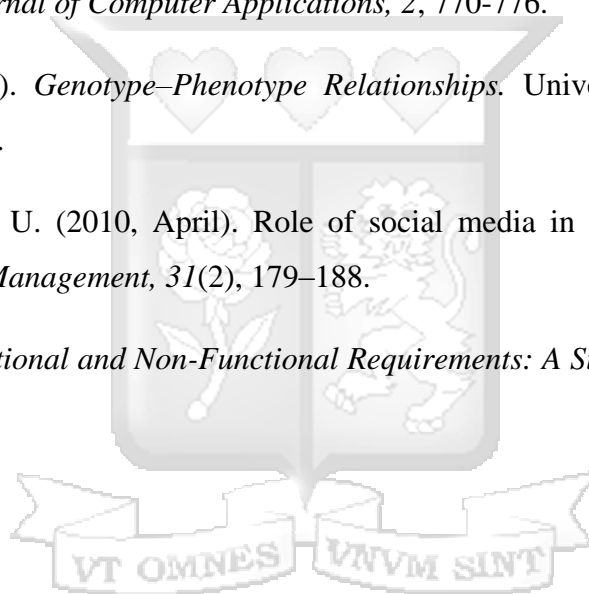
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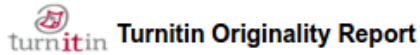
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Appendices

Appendix A: Turnitin Originality Report



Thesis by Martin Ndeto

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- 7 < 1% match (student papers from 10-Nov-2014)
[Submitted to London School of Marketing on 2014-11-10](#)
- 8 < 1% match (Internet from 11-Sep-2014)
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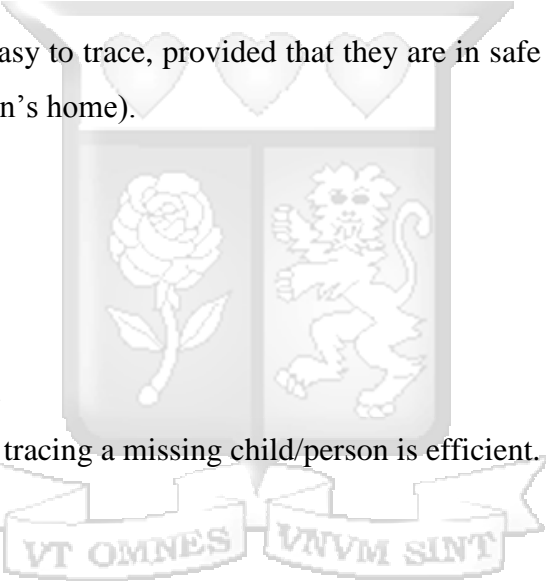
Appendix B: User Requirements Questionnaire

User Requirements Questionnaire

Researcher: Ndeto Martin Ndithi

MSc. IT, Strathmore University

This research is will be used for academic purpose only. Its main objective is to collect the user requirements to create a child tracing prototype in Kenya. Kindly provide your honest answers in the following questions. Please note that your responses will be treated as private and confidential.

- 
1. Missing children are easy to trace, provided that they are in safe hands (with the police or transferred to a children's home).
 - Strongly Agree
 - Agree
 - Neutral
 - Disagree
 - Strongly Disagree
 2. The current process of tracing a missing child/person is efficient.
 - Strongly Agree
 - Agree
 - Neutral
 - Disagree
 - Strongly Disagree
 3. A searcher is promptly alerted when a missing relative is found but not yet re-united with his/her family.
 - Strongly Agree
 - Agree
 - Neutral
 - Disagree
 - Strongly Disagree
 4. The current process of tracing a missing child/person is user friendly.
 - Strongly Agree

- Agree
- Neutral
- Disagree
- Strongly Disagree

5. I believe that the current processes and systems, if any, for tracing a missing child/person are secure and the records are safely kept

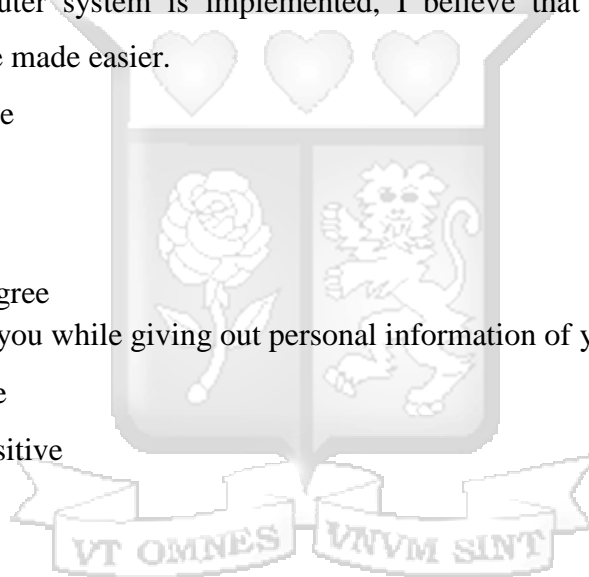
- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

6. If a proper computer system is implemented, I believe that tracing missing children (persons) would be made easier.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

7. How sensitive are you while giving out personal information of your loved ones

- Very Sensitive
- Not Very Sensitive
- Neutral
- I do not care



Appendix C: System Usability Questionnaire

System Usability Questionnaire

Researcher: Ndeto Martin Ndithi

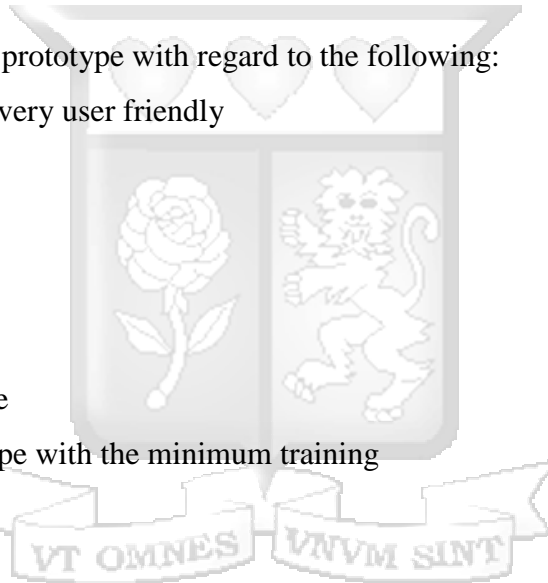
MSc. IT, Strathmore University

This research is will be used for academic purpose only. Its main objective is to find out users' experience in using the child tracing prototype in Kenya. Kindly provide your honest opinion on the same. Please note that your responses will be treated as private and confidential.

System Usability Scale

Kindly rate the child tracing prototype with regard to the following:

1. The user interface is very user friendly
 - Strongly Agree
 - Agree
 - Neutral
 - Disagree
 - Strongly Disagree
2. I can use this prototype with the minimum training
 - Strongly Agree
 - Agree
 - Neutral
 - Disagree
 - Strongly Disagree
3. Searching for a missing person using this system will take a shorter duration as compared to the current methods
 - Strongly Agree
 - Agree
 - Neutral
 - Disagree
 - Strongly Disagree



4. This question is practical and aims at testing the accuracy of the prototype. Kindly provide a list of five lost and found children to the researcher. After the researcher inputs them into the system, try searching them and note down your findings (Among them, how many were correctly identified?)

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5. The system provides a convenient way of tracing the missing persons

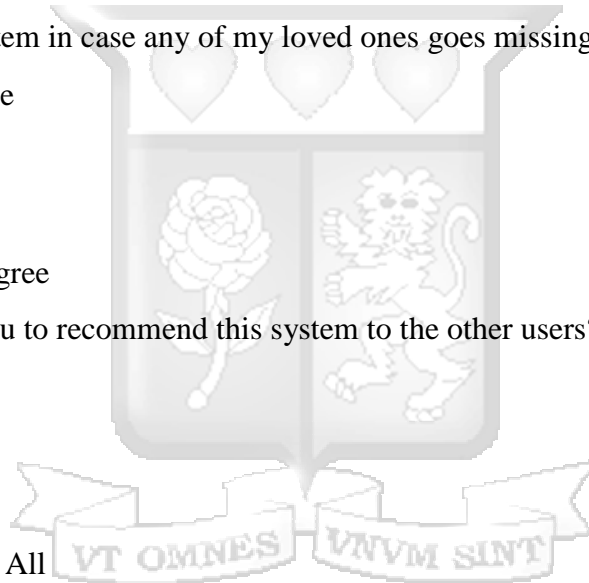
- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

6. I will use this system in case any of my loved ones goes missing.

- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

7. How likely are you to recommend this system to the other users?

- Very Likely
- Likely
- Neutral
- Not Likely
- Not Likely At All



8. Any Comments

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Appendix D: Interview Questions

Interview Questions

Researcher: Ndeto Martin Ndithi

MSc. IT, Strathmore University

This research is will be used for academic purpose only. Its main objective is to find out users' experience in using the child tracing prototype in Kenya. Kindly provide your honest opinion on the same. Please note that your responses will be treated as private and confidential.

Interviewee: **Location:**

Medium: **Date:**

1. If a child/person is missing, what should an ordinary citizen do?

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2. What is the current procedure of tracing a missing child/person?

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3. What are the challenges in tracing a missing child/person?

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4. How do you handle children who have been brought to you by “Good Samaritans”?

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5. What is the current process of re-uniting a lost and found child/person to his/her family?

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6. What are the challenges faced while re-uniting the lost and found child/person to his/her relatives?

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